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This report presents the results of a year-long pre- and postinstitute evaluation of the 6-week summer workshop for 221 primary grade teachers of disadvantaged children from 41 different New York City schools. The report is organized around the findings obtained from each of nine evaluation instruments and checklists used to measure (1) changes in science knowledge and information (in biological, earth, and physical science areas), (2) changes in attitudes toward science and science teaching, (3) changes in teacher behavior in the classroom, (4) changes in the schools and in the pupils, and (5) over-all effectiveness and suggested modifications of the Institute. Descriptive analysis of the data is given. Included is discussion of the background, characteristics, and selection of the teacher-participants and of the 15 supervisor-participants who were elementary school coordinators trained in additional teacher education and supervisory techniques as members of the instructional team of the workshop. Major findings are summarized in terms of the five areas of interest noted above, and conclusions are presented regarding the limitations of the Institute, the evaluation, and suggested modifications and improvements. All except one of the nine instruments, eight of which were developed by the evaluation team, are appended. (JS)

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FINAL TECHNICAL REPORT
ON THE INSTITUTE FOR: Teachers of Disadvantaged Youth: Science for Elementary Teachers CODE: OE6-42-036

AT: Hunter College of the City University of New York

DATES: February 1, 1966 August 12, 1966

SUBMITTED BY: Harold E. Tannenbaum
HAROLD E. TANNENBAUM, Director

September 30, 1967

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HUNTER COLLEGE
THE CITY UNIVERSITY OF NEW YORK
NDEA INSTITUTE
SCIENCE FOR CHILDREN IN DISADVANTAGED URBAN AREAS
-o-
695 PARK AVENUE - NEW YORK, N. Y. 10021
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Letter of Transmittal

During the academic year and summer of 1966, an NDEA Institute for Advanced Study was conducted at Hunter College. The Institute was unusual for several reasons: It was very large with a total of 240 participants; it was focused on the needs of teachers and supervisors from disadvantaged urban areas; it used as its subject matter the area of elementary school science; it concentrated on improving the instructional capabilities of primary grade teachers. In short, it was an inovative program in many ways.

As might be expected, all of the responsible personnel involved in mounting and implementing the program had clear hopes but also many concerns about the efficacy of such an undertaking. Would the program reach all, or even most, of the teachers? Would it help them overcome some of their fears of science and of teaching the subject matter? Would the program succeed in changing teacher behavior? Would teachers return to their classrooms and allow children to "dis--cover" science information rather than continue, as they had previously done, to "preach" science information to their children? And, most important of all, if all of these changes did take place in the teachers, would it make any difference in the children?

Of course, a considerable amount of time and money was allocated for the project. The NDEA funds alone amounted to almost a quarter of a million dollars. Beyond that, City University funds were allocated in the form of staff time, facilities, and general expenses. Then there were the time and efforts of New York City Board of Education personnel. The expenditure of such a large sum would have justified careful evaluation of the project. However, much more was at stake than even the expenditure of $350,000.

If the plan succeeded, or even showed promise of success with modifications based on its analysis, the pattern used during the first year might provide a model for other elementary school institutes in other places and in other subject matter fields.

In the light of this situation, the USOE and the City University of New York made funds available for a special study of the effectiveness of the program. The resulting study is reported in the attached document.

As Director of the Institute, it is my privilege to transmit the findings of the study to all concerned. At this same time I wish to acknowledge the helpful work of the evaluation team who carried out the study and particularly to commend Mrs. Barbara Heller who authored the report and led the evaluation team.

Respectfully submitted,
H. E. Tannenbaum
Harold E. Tannenbaum
Director

ACKNOWLEDGMENTS

The United States Office of Education provided the funds; Hunter College, the City University of New York provided the facilities, but without the assistance of a great many people this evaluation would not have been possible.

Dr. Harold E. Tannenbaum and Dr. Archie Lacey, Directors of the NDEA Institute in Elementary Science, supported and encouraged the study and the thinking on which it is based. Special appreciation is due to the Advisory Committee, Dr. Gordon Fifer, Associate Professor of Education, Hunter College; Dr. Maurice Lohman, Assistant Professor, Department of Research, Division of Teacher Education, City University of New York; and Dr. William Reiner, Professor of Education, Hunter College, for their guidance and judgment during the months of planning and preparation. Acknowledgment is also made to Dr. Albert J. Harris, Director, Office of Research and Development, Division of Teacher Education, The City University of New York, for his support.

The New York City Board of Education, the district superintendents and the principals of the 41 participating schools deserve special mention for their cooperation.

I wish space would permit mentioning individually each of the 15 supervisor-participants and more than 220 teacher-participants who completed the forms, took the tests and answered the many questions they were asked during the fifteen month duration of the project; then too we would like to acknowledge those teachers who participated in the classroom observations.

Nor would the study have been completed without Mr. Robert Tannenbaum, Research Assistant, who did all of the programming and who helped with the classroom observations. Mr. Tannenbaum was also largely responsible for the construction of the Test of Science Concepts.

Without Mrs. Zelda Block, Administrative Assistant, there would have been no study. Mrs. Block, while answering the phone and taking charge of the typing, duplicating, mailing and returns of all questionnaires and tests, managed to find and correct most errors, to answer most questions and to locate all lost materials with patience, grace, charm and competence.

Mrs. Minnie Miller, Miss Nadine Zelman, Miss Ann Katsefes and Miss Alice O'Connor, all contributed to the analysis - and reanalysis - of the data and to the typing - and retyping - of the final report.

Barbara R. Heller, Associate for Evaluation
Lecturer, Office of Research and Evaluation
Division of Teacher Education
The City University of New York

June, 1967

INTRODUCTION

Problem

During the past decade, as it became increasingly apparent that training in science was the key to the continuance of scientific and technological progress, science instruction received a great deal of attention. Interest in the teaching of science has increased and there is a growing trend for people from different disciplines to begin to examine the manner in which the subject is being taught: Textbook materials are rewritten; curricula are adapted; supplementary teaching and learning aides are available; new materials, ideas and techniques are developed. In addition, methodology and content courses are being added to the pre-service teacher education curriculum, and there is a growing emphasis on in-service education in science for the more than one million elementary school teachers in the country.

Concurrent with the emphasis on science instruction is the growing awareness of the needs of disadvantaged children and the promise that this new science, with its concern for individualized activities and process-centered orientation, may be very successful in meeting the specific needs of these children. The science that children from disadvantaged environments must learn however, is really no different from the science all children should master; all teachers should become familiar with the techniques, materials and ideas appropriate for a process-centered elementary school science program.

The problem is to provide such individualized in-service education for the vast number of teachers in disadvantaged area schools. The proposal for the NDEA Institute in Elementary School Science proposes a solution to the problem of educating a large number of people in the new materials and ideas available which stress the activity approach to science.

The NDEA Institute in Elementary School Science

In the Summer of 1966 the U. S. Office of Education, under Title XI of the National Defense Education Act, provided funds to conduct a workshop in science designed especially for and limited to 225 teachers in the primary grades (K-4) from disadvantaged area schools. The workshop lasted six weeks, from July 5 to August 11, 1966. The basic assumptions of the Institute workshop were that:

"A group of teachers, though uninformed in science, can learn a limited but valuable selection of science concepts and master techniques for developing activity and process-centered programs built around these concepts through a workshop program, and

"The over-all size of the workshop need not affect adversely the quality of an individual participants' experiences provided each participant is a member of a well-organized and well-led sub-group, and

"Teachers of the primary grades of disadvantaged area schools have many common problems, including the problem of weak science backgrounds."

The consequences resulting from these assumptions delimit the Institute:

1. The workshop was to be limited to 225 primary grade teachers of disadvantaged children

2. The workshop was to be devoted to a study of carefully selected concepts from three science areas, plus the materials and techniques needed for process-centered activity programs

3. Fifteen elementary school science coordinators were to be selected as members of the instructional team of the workshop

4. These coordinators were to be taught additional teacher education and supervisory techniques.

Although the complete statement of objectives for teacher-participants can be found in Appendix A., the most salient ones are summarized below. Teacher-participants are expected to:

1. Gain knowledge of
   a. selected basic concepts in the biological, physical and earth sciences
   b. the available materials and techniques for teaching these concepts to children

2. Learn techniques for
   a. exploring other science concepts and generalizations
   b. using curricular materials to teach processes and generalizations to their classes
   c. developing teaching styles appropriate for guiding inquiry in the classroom

3. Master skills in the use of
   a. laboratory materials
   b. educational materials and methods for teaching science

EVALUATION OF THE NDEA INSTITUTE IN ELEMENTARY SCHOOL SCIENCE

The original research plans proposed a year long evaluation of the teacher-participants to start during the Spring semester prior to the Summer of 1966 and to continue through the following year. The original proposal called for the "evaluation of the project including an examination of the changes in attitudes, knowledge and skills of the teacher-participant group as determined through paper and pencil and/or interview devices used with the total group and of changes in teaching behaviors and practices as determined by classroom observations of a selected sample of teachers."

The primary objective of the evaluation, as it developed, was to assess the effectiveness of the Institute, to determine how successful the Institute was in meeting its own goals. The consequences for the evaluation effort were to determine (1) whether teacher-participants were "uninformed in science" and had negative attitudes toward science, and (2) whether teachers were deficient in mastery of techniques, skills and materials for developing activity, process-centered programs, and to see if the workshop experience corrected and alleviated the pre-existing patterns.

The design was essentially a pre- and post- Institute contrast of specific behaviors selected for study. Each participant would be compared with himself; the pre-Institute results would provide the baseline against which any change would be measured.

The evaluation was directed toward five areas of interest: (1) changes in scientific knowledge and information, (2) changes in attitudes toward science and teaching science, (3) changes in behavior related to teaching science in the classroom, (4) change in the school and in ratings of pupils, and (5) over-all effectiveness of the Institute.

Instruments Used in the Evaluation

A copy of each of the measures used in the evaluation can be found in Appendices B through J. The battery of nine measures included:

Teacher-Participant School Checklist (Appendix B)
Supervisor-Participant School Checklist (Appendix C)
Test of Science Concepts (Appendix D)
Elementary Science Survey (Appendix E)
A "Measuring Meaning" Test (Appendix F)
Teacher-Participant Evaluation of Effectiveness (Appendix G)
Supervisor-Participant Evaluation ofA Evvectiveness (Appendix H)
Supervisor-Participant Observation Form (Appendix I)
Evaluators' Observation Schedule (Appendix J)

With the exception of the *Elementary Science Survey*, all instruments and checklists were developed by the evaluation team. A brief description of each of the measures and procedures used follows below:

Teacher-Participant School Checklist:

This was a self-rating scale administered to teacher-participants before and after the Institute, in April 1966 and again in March 1967. Each of the participants received a copy of the *Checklist* with instructions, and a return envelope. Since each respondent mailed her completed *Checklist* directly to the evaluators, a high degree of confidentiality was assured. In general, response to this measure was high and positive.

The *Checklist* was designed to elicit information about the teachers' general background, attitudes, abilities and interests toward teaching science as well as information about the schools' science programs and the pupils' interest in science. The *Checklist* contained sections on "Science in the School," "Science in the Classroom," a "Science Self-Rating Scale" and, "Science and the NDEA Institute."

Supervisor-Participant School Checklist:

This was a two-page questionnaire to be completed by the Supervisors in April 1966 and again in March 1967. Each supervisor was responsible for obtaining information about each school represented in his group. (See Table 1 for the number of different schools represented in each of the supervisory groups.)

It contained detailed questions about science instruction, equipment, supplies, and distribution of (science) responsibility in the schools. Information was sought about ordering books, supplies and equipment, amount of time devoted to science instruction, special science programs and facilities, etc. It was anticipated that this type of background knowledge would be of aid in determining any effects of the NDEA experience on the school itself.

Test of Science Concepts:

This test, developed specifically to measure scientific reasoning and science education information, was administered to all teacher-participants. It was part of a battery of tests given on July 5, the first day of the summer Institute and again on August 11, the last day of the Institute.

The test consists of six reading passages on different science subjects followed by seven multiple-choice questions for each passage. The first three of the passages were topics covered during the six-week period: motion and chosen frames of reference; temperature and change of phase; and living things responses to stimulae in their environments. The remaining three passages - classification of organisms, force and acceleration, energy changes in chemical systems - were not to be subject to direct instruction in the Institute classroom.

Elementary Science Survey:

This diagnostic instrument, constructed by Teachers College, Columbia University, was part of the battery administered to the teacher-participants at the beginning and end of the Institute. This is an eighty-four item multiple-choice test designed to diagnose deficiencies in science background. It contains items and areas covered in the course of the Institute as well as items and areas not directly covered; for our purposes the Elementary Science Survey provides a measurement of amount and kind of information and knowledge about science.

Measuring Meaning:

Included in the test battery administered at the beginning and end of the Institute was an adaptation of the Osgood "Semantic Differential", or Measuring Meaning Test. The semantic differential schema purports to measure changes in points of view along certain specified dimensions; our adaptation consisted of an evaluative and an understandability dimension.

The concepts to be measured included: Process-Centered Activities, Individualized Science Activities, Disadvantaged Children, My Teaching Skills and Techniques, Science Instruments and Materials, Myself as a Science Teacher, Scientific Investigations by Pupils, My Elementary School, "Difficult" Students, and Scientific Knowledge.

Teacher-Participant Evaluation of the Effectiveness of the Institute: The first section of this two-part opinionnaire consisted of 34 statements derived from the Institute's listed objectives. Each statement was rated on a 4-point scale ranging from, the "Institute has had an OUTSTANDING POSITIVE EFFECT ON,"to, the "Institute has had a NEGATIVE EFFECT ON." In the second section the participants were asked to list the specific areas in which they received and did not receive help in and, suggestions for improving the Institute.

This opinionnaire was administered at the end of the Institute to all teacher-participants as part of the battery of tests.

Supervisor-Participant Evaluation of the Effectiveness of the Institute: The fifteen group supervisors were asked to complete a two-part opinionnaire similar to the one described above for the teacher-participants. In this edition, supervisors were directed to evaluate the effectiveness of the Institute on the members of their group.

Behavior Observation Schedule: This was a classroom observation schedule developed to assist in the determination of changes in science teaching skills and techniques. Its primary purpose was to yield information about similarities and differences in the classroom behavior of teachers before and after the summer Institute.

Specific behaviors, related both to the Institute's immediate objectives and the objectives of good science teaching, were noted - what the teacher did, as well as how well and how often she did it. Some of the specific behaviors included the diversity and quality of materials used by the teacher in various stages during the lesson, errors in scientific terminology and explanations, individualized activities, etc. General behaviors included adequacy of preparation, poise, over-all quality of the lesson, etc.

Observations were to be conducted in 39 classrooms of a subsample of selected teachers. For a complete description of the sampling, see the section on Classroom Observations. The teachers were to be seen by the evaluation team in April 1966 (pre-Institute), October 1966 (post-Institute) and again in April 1967.

Observation Schedule for Supervisors:

A simplified and more structural version of the Schedule described above was adapted for use by the supervisors to observe the teachers in their groups in the classroom before and after the Institute. The pre-Institute observations occurred in April-June 1966; the post-Institute observations took place in March-April 1967. Returns on this Schedule were not complete and will not be considered in the report on the results of the study.

Selection of the Participants for the NDEA Institute

The original proposal specified acceptance of 225 teachers as participants in the Summer Institute; early in the Spring of 1966 each of the 15 supervisors previously chosen by the Directors made recommendations of candidates. A total of about 280 applications from teachers were received. Careful review of the applications by the Directors resulted in elimination of some, and final selection, by the end of the Spring semester, of 225 teacher participants. A complete description of the qualifications for both supervisor and teacher-participants can be found in the original proposal.

The Institute began on July 5 with 225 teachers and 15 supervisors; by the end of the six week period a total of 221 teacher-participants remained. Four persons dropped out of the Institute during the summer. All findings will be based on data from the 221 teacher-participants who completed the entire planned sequence of summer activities.

Description of the Fifteen Supervisors and Supervisory Groups

There were 15 groups generally working as separate units during the Institute. For a complete description of the summer sequence of activities and events, see the appropriate section in the original proposal. Each group was headed by a supervisor who was responsible for coordinating the activities of his group, for preparation and follow-up of total Institute events, and other specific and general supervisory and instructional responsibilities.

Thirteen of the supervisors were male, two were female. There were seven supervisors who were Assistants-to-Principals, five district science coordinators and three teachers who served as group supervisors. The Assistant Principals had supervisory authority and experience over the teachers with whom they worked, but were relatively untrained in science; the district coordinators had more science background but no official supervisory authority. The teachers of course, were peer-leaders of their groups. Two teacher supervisors were from disadvant--aged communities outside New York City; the participants in their groups taught in schools outside the City system. The rest of the supervisors, and the teacher-participants in their groups, were all employees of the New York City Board of Education.

Table 1

Background Data Describing the Fifteen Supervisory Groups

	Groups														
Description:	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Sex of supervisor	M	M	M	M	F	M	M	M	M	M	M	M	M	M	F
Position of supervisor	T	AP	Coor	Coor	Coor	Coor	AP	T	AP	AP	T	Coor	AP	AP	AP
Location of school system	NYC	NYC	NYC	NYC	NYC	NYC	NYC	Long Beach	NYC	NYC	Green burgh	NYC	NYC	NYC	NYC
N schools in group	1	3	5	6	5	2	3	3	2	1	6	1	1	1	4
N in group	19	15	10	17	17	15	16	11	15	14	14	16	12	15	15

Legend:

T = Teacher
AP = Assistant Principal

In five of the fifteen groups all of the participants were in the same one school during the year prior to the Institute. There were a total of 41 different schools, one of which divided its teachers among three groups. Two groups had teacher-participants from as many as six different schools. The median number of schools per group was three; the median number of participants per group was 15, with a range from 10 to 19. Table 1 summarizes these descriptive data for the fifteen groups. (See Table 1, page 7).

Description of the Teacher-Participants

Table 2 presents the distribution of participants by sex, age and marital status. These data are based on information contained in the "Application for Admission" and "Application for Stipend" submitted by each participant before the start of the Institute. (See Table 2, page 9).

More than three-quarters, 76 per cent, of the total number of participants are female: Group #03 was exclusively female; group # 07 had the greatest percentage of male participants - almost 38 per cent of group #07 was male.

Over thirty per cent of the total teacher group was 24 years old or younger at the beginning of the Institute; an additional 22 per cent were between the ages of 25 and 29. Interestingly, 15 per cent of the total group was 45 years or older. Group differences in age are apparent: group #12 may be described as the youngest group with 75 per cent of the teachers 24 years of age or younger. Contrast this with group 03 in which only ten per cent of the participants fall within that age category, and 60 per cent of the participants were 45 years or older.

Approximately 56 per cent of all participants were married, 38 per cent of the total group was single and the remaining six per cent widowed, divorced or separated. There is a fairly high rank-order correlation, .57, between age and marital status: The youngest groups (greatest percentage below 29 years old) tend to have the largest percentage of never-married participants. Additional information describing the academic and professional backgrounds of the participants are summarized in Tables 3 (see page 10) and 4 (see page 12).

Table 3 summarizes, by group and for the total combined, the percentage of teacher-participants by degree held; by major; and by semester hours, graduate and undergraduate, of science and science education courses. (Upon satisfactory completion of the Institute each participant received seven graduate credits from Hunter College.)

Prior to the Institute, 57 per cent of the total number of participants had taken courses in excess of the baccalaureate degree and about 13 per cent had completed courses beyond the master's level. Three participants did not have any degree. Differences exist between groups; for example, almost one-quarter of the participants in groups # 02, 04, and 05 had credits beyond the master's degree; none of the 14 participants in group #10 had yet received a master's, while in group #08 all of the participants had progressed beyond the baccalaureate.

Table 2

Description of the Teacher-Participants in the Fifteen Supervisory Groups

	Percentages by Groups															Total	
Description	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	N	%
Number	19	15	10	17	17	15	16	11	15	14	14	16	12	15	15	221	100.0
Sex																	
Male	15.8	26.7	0.0	29.4	35.3	13.3	37.5	36.4	33.3	7.1	21.4	12.5	33.3	26.7	26.7	53	24.0
Female	84.2	73.3	100.0	70.6	64.7	86.7	62.5	63.6	66.7	92.9	78.6	87.5	66.7	73.3	73.3	168	76.0
Age																	
20-24	31.6	20.0	10.0	17.6	23.5	60.0	25.0	18.2	13.3	28.6	35.7	75.0	50.0	40.0	26.7	71	32.1
25-29	36.8	20.0	0.0	17.6	5.9	26.7	43.8	18.2	26.7	14.3	21.4	6.2	33.3	33.3	20.0	49	22.2
30-34	15.8	0.0	0.0	5.9	11.8	0.0	12.5	9.1	6.7	14.3	0.0	0.0	0.0	0.0	6.7	13	5.9
35-39	10.5	26.7	10.0	5.9	41.2	6.7	0.0	9.1	40.0	21.4	28.6	0.0	16.7	13.3	20.0	37	16.7
40-44	0.0	13.3	20.0	23.5	0.0	0.0	12.5	9.1	0.0	7.1	14.3	0.0	0.0	6.7	13.3	17	7.7
45 +	5.3	20.0	60.0	29.4	17.6	6.7	6.2	36.4	13.3	14.3	0.0	18.8	0.0	6.7	13.3	34	15.4
Marital Status																	
Married	26.3	73.3	80.0	64.7	64.7	33.3	43.8	54.5	53.3	78.6	71.4	18.8	66.7	46.7	80.0	123	55.7
Widow, etc.	10.5	13.3	20.0	5.9	17.6	0.0	0.0	9.1	13.3	7.1	0.0	0.0	0.0	0.0	0.0	14	6.3
Single	63.2	13.3	0.0	29.4	17.6	66.7	56.2	36.4	33.3	14.3	28.6	81.2	33.3	53.3	40.0	84	38.0

Table 3

Educational Background of Teacher-Participants by Group

Percentages by Groups

Description	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	Total N	Total %
Degree:																	
None	0.0	0.0	20.0	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3	1.4
B. A.	5.3	0.0	30.0	11.8	17.6	13.3	37.5	0.0	33.3	28.6	28.6	31.2	33.3	6.7	26.7	44	19.9
B. A. +	73.6	60.0	20.0	52.9	52.9	53.3	56.2	81.8	46.7	71.4	35.7	50.0	58.3	73.3	60.0	126	57.0
M. A.	15.8	13.3	20.0	5.9	5.9	13.3	0.0	0.0	6.7	0.0	21.4	0.0	0.0	13.3	13.3	19	8.6
M. A. +	5.3	26.7	10.0	23.5	23.5	20.0	6.3	18.2	13.3	0.0	14.3	18.8	8.3	6.7	0.0	29	13.1
Major:																	
Behav Sci	10.5	13.3	0.0	0.0	17.6	0.0	50.0	9.1	13.3	35.7	28.6	43.8	16.7	6.7	40.0	43	19.4
Soc Sci	5.3	20.0	0.0	17.6	5.9	0.0	6.3	9.1	6.7	14.3	0.0	0.0	25.0	6.7	0.0	17	7.7
Educ	68.4	46.7	70.0	41.2	70.6	100.0	31.2	27.3	60.0	35.7	64.3	37.5	8.3	66.7	46.7	116	52.5
Sp Educ	5.3	0.0	0.0	5.9	0.0	0.0	0.0	9.1	6.7	0.0	0.0	0.0	0.0	0.0	0.0	4	1.8
Eng, Sp	10.5	13.3	10.0	11.8	0.0	0.0	6.3	9.1	6.7	0.0	7.1	0.0	16.7	0.0	0.0	13	5.9
For Lang	0.0	0.0	10.0	17.6	0.0	0.0	6.3	9.1	0.0	7.1	0.0	12.5	16.7	13.3	6.7	14	6.3
Math, Sci	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.1	0.0	6.2	8.3	0.0	0.0	3	1.4
Music, Art	0.0	0.0	10.0	0.0	0.0	0.0	0.0	18.2	6.7	0.0	0.0	0.0	8.3	0.0	0.0	5	2.3
Bus. Adm	0.0	6.7	0.0	5.9	5.9	0.0	0.0	9.1	0.0	0.0	0.0	0.0	0.0	6.7	6.7	6	2.7
Semester Hrs Sci,Sci Ed																	
0-4	5.3	6.7	0.0	5.9	11.8	0.0	12.5	9.1	6.7	7.1	7.1	0.0	16.7	0.0	6.7	14	6.3
5-9	26.3	33.3	50.0	35.0	52.9	0.0	31.2	27.3	13.3	57.1	28.6	50.0	41.7	20.0	26.7	72	32.6
10-14	36.8	33.3	30.0	29.4	17.6	60.0	43.7	18.2	53.3	28.6	35.7	31.2	16.7	66.7	46.7	82	37.1
15-19	21.1	13.3	10.0	5.9	11.8	26.7	6.3	27.3	26.7	7.1	28.6	12.5	8.3	6.7	13.3	33	14.9
20-24	10.5	0.0	10.0	5.9	5.9	13.3	0.0	0.0	0.0	0.0	0.0	0.0	16.7	6.7	0.0	10	4.5
25 + (45)	0.0	13.3	0.0	17.6	0.0	0.0	6.3	18.2	0.0	0.0	0.0	6.2	0.0	0.0	6.7	10	4.5

Complete information on academic major was available and is also tabulated in Table 3. Included in the behavorial sciences category are psychology, sociology and anthropology majors; history, civics and economics are categorized under social studies. With the exception of "special education" the remaining categories are self explanatory. Under the special education classification are included majors in physical and health education as well as education for the handicapped. The major tabulated was the major of the highest degree held; for 78 per cent of the total group it was the baccalaureate major, and for the 22 per cent with a master's degree that major subject area was used.

More than half, 53 per cent, of the total group majored in education; all participants in group # 06 and only eight per cent of those in group # 13. For the combined total, the next most popular major was the behavorial sciences although again the differences between groups are great; there were no behavioral science majors in groups # 03, 04 and of course, 06, while at least 40 per cent of groups # 07, 12 and 15 fell in this category. One-quarter of the teachers in group # 13 were social science majors and almost 20 per cent, 18, of those in group # 08 majored in art or music. Three participants majored in science or mathematics.

Academic minors will not be presented in tabular form although completed information is available. There was one mathematics minor, one minored in biology, one in physiology and four minors in science of the total of 221 participants.

The number of semester hours, graduate and undergraduate, in science or science education courses is tabulated separately for each of the 15 groups and for the combined total. The percentage of participants having completed 0-4, 5-9, 10-14, 20-24 and 25 or more semester hours is recorded in Table 3. Thirty-seven per cent of the total groups combined completed 10-14 semester hours prior to the Institute, about 33 per cent completed between 5 and 9 hours, and 15 per cent completed 15-19 semester hours in science or science education. More than 18 per cent of group # 08 had more than 25 hours, and all teacher-participants in group # 06 had at least 10-14 semester hours without crediting for the Institute hours.

Forty-six per cent of the total of 221 participants had, including the semester before the start of the Summer Institute, three years or less of teaching experience. Another 26 per cent had between 4 and 6 years experience; about 28 per cent had more than seven years teaching experience and three per cent of these had taught for 21 or more years. These figures are summarized in Table 4. The individual differences between groups is notable: in group # 15 no participant had more than between 7 and 10 years experience; in group # 12 while more than 80 per cent had taught from one to three years, the remainder of the teachers each had more than 21 years of teaching experience.

Although the original proposal was restricted to teachers in grades K-4 it was not possible to select qualified applicants solely from these grades. As can be seen in Table 4, approximately 64 per cent of

Table 4

Teaching Background of Teacher-Participants by Group

Percentages by Group

N yrs. experience	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	Total N	Total %
1-3	47.4	20.0	20.0	47.0	47.0	53.3	56.2	45.4	26.7	35.7	50.0	81.2	75.0	33.3	46.7	102	46.2
4-6	42.1	40.0	20.0	17.6	23.5	33.3	31.3	0.0	20.0	28.6	21.4	0.0	16.7	40.0	46.7	58	26.2
7-10	5.3	13.3	0.0	11.8	5.9	0.0	12.5	36.4	26.7	21.4	21.4	0.0	0.0	20.0	6.7	26	11.8
11-15	5.3	26.7	10.0	11.8	11.8	0.0	0.0	0.0	20.0	14.3	7.2	0.0	8.3	6.7	0.0	18	8.1
16-20	0.0	0.0	30.0	11.8	11.8	6.7	0.0	18.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10	4.5
21 +	0.0	0.0	20.0	0.0	0.0	6.7	0.0	0.0	6.7	0.0	0.0	18.8	0.0	0.0	0.0	7	3.2
Grade Taught 1965-66:																	
K	5.3	20.0	20.0	5.9	11.8	0.0	6.2	0.0	6.7	0.0	7.1	12.5	0.0	0.0	6.7	15	6.8
1-4	68.4	66.7	60.0	64.7	47.1	46.7	25.0	27.3	53.3	92.9	78.6	18.8	58.3	86.7	60.0	126	57.0
5-6	26.3	13.3	10.0	5.9	29.4	6.7	37.5	18.2	26.7	0.0	14.3	68.8	33.3	13.3	26.7	50	22.6
Sp class	0.0	0.0	10.0	5.9	5.9	0.0	18.8	0.0	6.7	0.0	0.0	0.0	0.0	0.0	6.7	8	3.6
OTP(sci)	0.0	0.0	0.0	17.6	0.0	6.7	6.2	0.0	6.7	0.0	0.0	0.0	8.3	0.0	0.0	7	3.2
Cluster	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3	1.4
Other	0.0	0.0	0.0	0.0	0.0	6.7	6.2	45.4	0.0	7.1	0.0	0.0	0.0	0.0	0.0	8	3.6
No Resp	0.0	0.0	0.0	0.0	5.9	13.3	0.0	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4	1.8

the total number of participants were K-4 teachers during the year 1965-66. Another approximately 23 per cent of the total group taught grades 5 and 6, about four per cent of the participants taught special classes (CRMD, Citizenship classes) and another four per cent were special teachers of reading, drama, art and other subject areas. There were seven OTP (Other Teacher Personnel) in science and three cluster teachers. The percentage of participants by grade or class category is presented separately for each of the groups. (See Table 4, page 12).

In summary, the average teacher in the 1966 NDEA Institute participated in a group of 15 persons, composed of persons from three different schools in New York City and headed by a male Assistant Principal. She is most likely to be female, never married and below the age of 29. She has some graduate credits beyond the baccalaureate degree, a probable major in education and by the start of the Institute was likely to have completed between 5 and 14 semester hours in science and science education. During the semester prior the Institute it is probable that she taught in grades 1-4; she has had between one and three years experience in teaching.

Description of the Results

It was decided to treat all the findings obtained from each of the instruments and measures used in the evaluation as a separate section in the following chapter on Results. The rationale for including together the results of both the pre- and post-Institute measures - rather than presenting all pre-Institute results then all post-Institute results - was economy of space and ease of comparisons.

The first section will describe the findings obtained from the two administrations of the Teacher-Participant School Checklist. The analyses of these data will provide some information about science in the schools from which the participants came, about the way the participants taught science, some indications about how they feel about teaching science, and science attitudes in general. It will also contain some discussion about participants' expectations in regard to the forthcoming NDEA Institute. The results obtained one year later, after the Institute, are also presented. Comparsions can be easily made for each of the items in the Checklist; we will present information on any changes in the school and in the participating teacher that the participant ascribes to her summer experience.

As confirmation on what actually occurred in the school - both Institute-related and Institute-independent, we have some sketchy data obtained from two administrations of the Supervisor-Participant School Checklist. It was our intention to use this data to indicate school-wide effects, if any, of the NDEA Institute.

Immediately following we will present the results of the Classroom Observations conducted by the evaluation team. This will provide again some information on how a selected group of participants actually taught a demonstration lesson and, more importantly, the changes in their teaching of science as a result of the NDEA Institute.

We had hoped to be able to present the results of Classroom Observations by the Supervisors both before and after the Institute, but there was insufficient data to be able to do so. What data does exist is not comparable and, in addition, the conditions under which the Supervisors observed their participants was not standardized.

An issue of great concern is changes in the amount and kind of science information the participants learned during the six-week workshop period. The results of the Test of Science Concepts and the Elementary Science Survey will direct attention to this issue.

We were also interested in teachers' attitudes toward science; we felt very strongly that it was attitude that underlay the way they taught - or did not teach - science, as well as their willingness to learn about science. The Semantic Differential, or "Measuring Meaning Test", summarizes the initial and post-Institute attitudes of the teacher-participants to (1) the techniques and processes stresses in the Institute and (2) to the pupils in the classrooms.

The final section of results will present the participants' ratings of the Effectiveness of the Institute; all participants and many of the Supervisors completed these evaluations. Suggestions and needed modifications, as seen by the participants themselves, will be explored.

Treatment of Data

With three exceptions, the Test of Science Concepts, the Elementary Science Survey and part I of the Teacher-Participant Evaluation of the Effectiveness of the Institute, all other data were hand-scored and tabulated.

Content analyses were done: in all cases the unit of measurement was "scoreable response." That is, each statement made was analyzed into its componant parts and each part was tallied separately. Thus, a comment such as, "I want to learn more science this summer so I can teach my pupils how to discover things by themselves", was tallied once under "to learn more science" and once under "discovery method for pupils." There were, as a result, more scoreable responses than statements. It is also important to keep in mind that there were more statements usually than there were respondents, i. e., each respondent could - and did - usually make more than one response to the open-ended items.

All results were obtained and analyzed separately for each supervisory group; in most cases the results will be presented for each group separately. In those instances where it would require too much space only total groups' combined results are presented; however, group data are also available.

Due to other than research-design limitations all statistical analyses are descriptive. Shortage of time and money prevented more sophisticated comparisons - correlations between tests, etc. Again however, the data for such statistical treatments are available and the data may be reanalyzed in the future.

One additional word: The .05 level of confidence was the minimum accepted for significance. Any comparison that did not meet the .05 level of confidence is considered not significant (NS) in the report. That is not to say however that all tests meeting this criterion of statistical confidence actually have educational significance as well. Some of the statistically significant results, as will be discussed in the summary of the report, may be due to the design of the study, the size of the sample, or other factors, and thus may not have any relevance to behavior in the classroom, or more importantly, result in changes in pupil performance.

RESULTS OF THE TEACHER-PARTICIPANTS' RATINGS: SELF, SCHOOL, STUDENTS

The Teacher-Participation Checklist, administered in April 1966 (pre-Institute) and again in March 1967 (post-Institute) yielded additional information about the participants' recent career history, future teaching plans and attitudes toward science teaching and the classroom.

Two forms, I and II of the Checklist were used. Both forms were almost identical; the major changes were in dates, e. g., "Do you expect to be in this school during 1966-1967", or "1967-68?" and in questions about expectations. In the first administration, for example, the participants were asked what they expected to learn and accomplish as a result of the Institute experience, while for the post-administration the question was "What did you learn and accomplish..." A copy of the Checklist is found in Appendix B.

Why include in an evaluation this type of open-ended instrument? There are several reasons: One is that it gives participants the best opportunity to express themselves in a situation where their comments and responses are not delineated by a "forced-choice," or pre-determined category. In retrospect we would not have been able to anticipate and provide for the variety of possible responses we obtained, nor would a more structured technique allowed for the depth of the comments and the flavor of individual styles of response. Several suggestions may not have appeared or would not have appeared in the same form.

Some of the questions asked did not prove useful, neither to the participants nor to the evaluation, and should therefore be deleted. There was also some difficulty in the wording of some questions: revisions of the instrument is necessary for greater clarity and understandability on the part of the respondents and less ambiguity in interpretation for the evaluation. In general however, the instrument has been most useful in both the new information it yielded and in the confirmation of results obtained elsewhere.

As already noted this Checklist was individually sent to each of the 221 participants. Return envelopes were provided and the instructions to the teachers stresses confidentiality and anonymity of responses. After one follow-up letter requesting completion and return of the April 1966 Checklist a total of 209 responses were returned. Table 5 summarizes the number and percentage of responses, by group and for the total population, to both administrations of the Teacher-Participation Checklist.

Table 5

Number and Percentage of Respondents to Both Administrations of The Teacher-Participant Checklist

Group:	Total N	Checklist I (Pre)		Checklist II (Post)	
		N	Per Cent	N	Per Cent
01	19	16	84.2	10	52.6
02	15	15	100.0	14	93.3
03	10	10	100.0	9	90.0
04	17	16	94.1	13	76.4
05	17	16	94.1	14	82.3
06	15	12	80.0	9	60.0
07	16	16	100.0	13	81.2
08	11	11	100.0	8	72.7
09	15	15	100.0	11	73.3
10	14	14	100.0	10	71.4
11	14	14	100.0	9	64.2
12	16	15	93.8	14	87.5
13	12	12	100.0	6	50.0
14	15	15	100.0	10	66.7
15	15	15	100.0	10	66.7
Total	221	212	95.9%	160	72.4%

Approximately 96 per cent of the total group responded the first time. In ten of the 15 groups response was complete and no more than three persons in any group failed to respond.

April 21 was closed as the cut-off date for response to the second administration of the Checklist. A total of 160 responses, about 72 per cent of the total group, were received after one follow-up request. The percentage of responses was not as great as the percentage responding the first time. For example, only half of group 13 responded to Checklist II, while 100 per cent responded the first time. However, as many as 93 per cent of group 02 responded to the second administration, and more than three-quarters of groups 03, 04, 05, 07, and 12 returned the post-Institute form.

Ninety-eight per cent of the total number of respondents to Checklist I, a total of 205 teachers, were in their school for the entire year 1965-66 preceding the Institute. Of the total 209 respondents, only six per cent (13 teachers) planned to be in a different school during the year after the Institute. Another eight per cent (17 persons) expected to have different positions or expected to be teaching at other grade levels (in the same school) for the year 1966-67. These figures are based on statements made in response to Checklist I, and are summarized in Table 6. Data based on responses to Checklist II (March 1967) provide a comparison of stated expectations concerning future teaching plans with actual teaching positions for the year. As can be seen in Table 6 (see page 18), 16 persons were in different schools during the year immediately following the Institute. Included in these 16 however, are five on maternity leave not expectating to return. One of the 16 became a Principal, and another an Assistant Principal in new schools.

More interesting however, is the fact that of the original 13 people expecting to be in different schools, four remained in the same school, two did change schools, and the remaining seven did not respond to the questionnaire. In other words, 14 of the 16 persons in new schools did not expect to be there in April of 1966. Thus it is apparent that there were either last-minute decisions to change schools or, alternatively, some participants did not inform us of their future expectations. It is impossible to determine how many of the 61 non-respondents also changed schools or assignments.

There were a total of 79 participants who held different positions and/or taught at different grade levels in 1966-67 than they anticipated in the previous school year. As a matter of fact, only 12 of the initial 17 who indicated this type of change actually did make the change; one of the 17 went to a different school, two persons stayed in the same grade and in the same position, and the remaining two did not respond to Checklist II.

One of the most distressing aspects of action research in school settings is the lack of control over the movement of subjects: children are promoted, schedules changed, families moved. Teachers are reassigned, participate in even newer programs, transfer, resign and of course, have babies. Even in those cases where the teachers' movement is within the system or even within the same school, the move may represent a reward of be an expression of disfavor, and the effect on the teachers' perspectives, behaviors, perceptions and attitudes cannot be predicted. This will be discussed more fully.

Science in the School

Participants were asked "if there was a special science program in their school, to briefly describe any such special program and to indicate who was responsible for teaching science to the children in their class."

Based on the 1966 returns for the year prior to the start of the Summer Institute, only five of the 41 different schools had a program which may accurately be described as a special science program. Three of these schools comprise one group (#08) from a suburban school district involved in a departmentalized elementary-level program; in these schools science was taught by selected specialist science teachers. One individual (in group #05) was involved in a team-teaching program and the

Table 6

Number of and Location of Teacher-Participants, by Group, for 1965-66 and 1966-67

Group	Total N Responses Checklist I	N in school entire 1965-1966 year	N expecting different school, 1966-67	N expecting different grade, 1966-67	Total N Responses Checklist II	N different school 1966-67	N different grade 1966-67
01	16	15	1	2	10	0	8
02	15	15	1	2	14	21	9
03	10	10	-	-	9	0	3
04	16	15	-	-	13	1	6
05	16	16	3	1	14	0	9
06	12	12	-	2	9	1	8
07	16	16	1	5	13	0	6
08	8	8	1	2	8	1	3
09	15	15	-	-	11	1	3
10	14	14	-	-	10	1	5
11	14	14	1	-	9	3	3
12	15	15	-	1	14	0	3
13	12	10	-	1	6	0	2
14	15	15	2	-	10	4	7
15	15	15	3	1	10	2	4
Total	209	205 (98.1%)	13 (6.2%)	17 (8.1%)	160	16	79

other participant (in group #03) was involved in a program described as "experimental." In all there was a total of nine persons in five dif-derent schools involved in a special science program.

In almost each of the remaining 36 schools, OTPS, cluster teachers or consultants are used to supplement classroom instruction in science, although in none of these schools did there appear to be an organized program. It seems however, that each of the teacher-participants in a school using supplementary science personnel actually worked with them.

During 1966-67 there was no substantial change in the number of schools involved in special science programs, although there was a very small number of instances where participants discussed "science enrichment programs," indicating at least, some additional attention being paid to science. Although not every grade or class participated, there is some evidence that many more schools were using cluster teachers and OTP's to teach science than had been previously noted; in addition some change was evidenced in the extent to which these personnel were now to be utilized throughout the school. This is not, however, necessarily a result of our Institute program but may reflect city-wide policies in the use of cluster teachers.

What is particularly heartening is that in many instances the participants we trained were being used as the science experts in the schools; in one school, all three participants became cluster teachers responsible for teaching science; in another school one participant taught science enrichment; in another, one became the science member of the team-teaching experiment; in yet another school a participant became the science coordinator; and finally, one sixth grade teacher voluntarily taught special science lessons to a fourth grade class when her (sixth grade) pupils "went to French".

Participants were asked if they were "responsible for teaching science to the pupils in their class". An analysis of their responses for 1965-66 was made and the results tabulated in Table 7 (page 20). One hundred and fifty-two participants, about 72 per cent of those responding to Checklist I, indicated that they themselves were directly and primarily responsible for teaching science to their pupils during that school year. Sixteen per cent of the total was responsible for preparing and following-up science lessons taught by the OTPS or cluster teachers, and eleven per cent of the respondents said they had no responsibility for teaching science to pupils in their classroom. (Included in this latter group are seven OTP's however, whose full-time responsibility was teaching science.) As evidenced by Table 7, dif-derences exist among groups: All respondents in group 03, 05 and 11 taught science to the pupils in their classes while more than one-third of the respondents in groups 06 and 08 said they were responsible for preparing and follow-up lessons by OTP's.

In 1966-67, based on the responses of the 160 participants returning Checklist II, approximately the same percentage, about 74 per cent, were responsible for teaching science to the pupils in their classes. The major difference was in the very much smaller percentage - about two per cent as compared with 16 per cent - of teachers who were responsible for preparing their class and providing follow-up lessons

Table 7

Distribution of Responsibility of Teacher-Participants for Science Instruction, 1965-66

Groups

Teach Science	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	Total N	Total %
Yes	8	6	10	13	16	5	12	7	12	9	14	12	5	11	12	152	71.7
No (OTP)	4	1	-	1	-	4	2	4	-	2	-	1	-	4	1	24	11.3
Yes-No: Follow-up	4	8	-	1	-	3	2	-	2	3	-	2	7	-	2	34	16.0
No Response to item	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	2	1.0
Total	16	15	10	16	16	12	16	11	15	14	14	15	12	15	15	212	100.0%

Note: 212 is the total number of teachers responding to Checklist I.

Table 8

Distribution of Responsibility of Teacher-Participants for Science Instruction, 1966-67

Groups

Teach Science	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	Total N	Total %
Yes	5	11	9	11	8	5	10	3	9	7	8	14	6	3	9	118	73.7
No (OTP)	4	2	-	2	4	4	3	4	2	2	-	-	-	5	-	32	20.0
Yes-No:	1	-	-	-	2	-	-	-	-	-	-	-	-	-	-	3	1.9
NR to item	-	1	-	-	-	-	-	1	-	1	1	-	-	2	1	7	4.4
Total	11	14	9	13	14	9	13	8	11	10	9	14	6	10	10	160	100.0%

for the science OTP's, (see Table 8, page 20). In the 1966-67 school year, 20 per cent of the group, as compared with 11 per cent in 1965-66, said they were not responsible for teaching science to the pupils in their classroom. (This again includes the clusters and OTP's themselves, who teach science as a full-time responsibility, but who do not have their own class.) These findings substantiate the impression that there is a tendency to use our participants as science "experts", cluster teachers and science OTPs, rather than classroom teachers.

School patterns are interesting: all respondents in group 03 and 11 still teach classroom science as do groups the participants in 12, 13, and 15. Group 05 now has more science taught by OTPs and cluster teachers as do groups 06, 08 and 14. A greater percentage of respondents in group 02 currently teach science to the pupils in their classrooms, as compared with the school year preceding the Institute.

Interestingly, those 16 per cent (Checklist I) responsible for follow-up lessons indicated that they averaged as much time in instruction in science as the group directly responsible for teaching the entire lesson. A comparison of average number of minutes per week spent in science instruction was made for two subgroups: (1) those that teach science and, (2) those that prepare for and follow-up science lessons. The results, reported in Table 9 (page 22) are presented to the nearest whole minute. Although there is, in general, no difference in time spent teaching, it would seem reasonable to conclude that the pupils in classes served by science OTPs actually receive more minutes of science instruction than do pupils in classes where the classroom teacher teaches science. (Add the OTP lesson to the time reported for preparations and follow-ups.)

An analysis of minutes per week of science instruction was also made by grade level taught during 1965-66. The divisions for grade level were K; grade 1-4; grade 5-6; special classes; OTP's, cluster teachers. The results can be summarized as follows: teachers of grades 5-6 averaged 96 minutes per week of science instruction; teachers of grades 1-4 averaged 81 minutes per week, and kindergarten teachers averaged 49 minutes per week. Teachers of special classes reported the highest average; they indicated that they spent 102 minutes per week in science instruction. Of course, this comparison excludes the science OTP's whose full-time responsibilities are science instruction.

There were only 127 teacher-participants who ennumerated the number of minutes per week spent in science instruction on both administrations of the Checklist. Approximately 43 per cent of these indicated that they spent more time on science in 1966-67 than they did in 1965-66. Twenty-three per cent spent approximately the same amount of time and the remaining 34 per cent indicated (partly because of reassignments, new positions, etc.) that they personally spent less time teaching science after the Institute than they had done prior to the experience. No other analysis of time spent in teaching science was attempted, and caution should be exercised in drawing conclusions: the wording of the question seemed fairly specific although the responses seem to indicate ambiguity in interpretation - we are not certain whether the respondents are reporting the time they spend or the amount of time of science instruction the pupils in their classes receive.

Table 9

Average Number of Minutes Per Week Spent in Science Instruction, 1965-66, for Teacher-Participants Who Were and Were Not Responsible for Teaching Science

Group	Teach Science		Follow-up and Preparation	
	N	Average N Minutes	N	Average N Minutes
01	8	74	4	70
02	6	61	8	83
03	10	59	0	-
04	12*	76	1	75
05	15*	99	0	-
06	5	68	3	107
07	11*	104	2	83
08	7	68	0	-
09	12	95	2	110
10	9	92	3	75
11	14	134	0	-
12	12	65	2	68
13	5	82	7	53
14	11	70	0	-
15	12	74	2	53
Total	149	79	34	75

Note: * One respondent in each of these groups did not complete the questionnaire item dealing with amount of time spent in science instruction (Checklist I).

Table 10 summarizes the number of participants who said that, during 1965-66, they taught science by itself or combined with other subject areas. Approximately 19 per cent of all groups combined - 39 persons - taught science, before the Institute, as a separate subject area. The remainder of the respondents usually stressed one (about 39 per cent) or several other subject matter areas.

For the total group, the social sciences was the area most frequently reported stressed in the teaching of science, followed by the language arts (which includes reading.) Several of the teacher-participants reported that math and science were taught together. The differences between groups are interesting. For example, groups 01, 07, 12 and 15 stress the language arts while groups 02, 04, 05, 06 09, 10, 13, and 14 stress social studies.

After the Institute about 21 per cent - 31 persons - of the total number of respondents said that they taught science alone; approximately 49 per cent taught science with one other subject matter area, and the

Table 10

Number of Teacher-Participants, by Group, Teaching Science as a Separate Subject Area or Combined with Other Subject Areas

Subject Area Stressed	Groups 01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	Total N	Total %
Science alone:																	
Pre-	4	2	1	4	5	1	3	2	4	-	4	2	1	3	3	39	18.7
Post-	2	1	1	5	4	2	2	1	1	2	3	4	-	-	3	31	20.9
Sci + one area:																	
Pre-	8	6	4	7	4	5	7	4	1	9	6	9	4	3	5	82	39.2
Post-	5	5	5	7	5	4	9	4	6	2	2	9	2	4	3	72	48.6
Sci + sev.areas:																	
Pre-	4	7	5	5	7	6	6	2	10	5	4	4	7	9	7	88	42.1
Post-	1	6	3	1	5	3	1	1	4	5	3	1	4	4	3	45	30.4
Sci + math																	
Pre-	2	1	3	2	3	2	3	-	3	4	2	2	1	4	5	37	14.4
Post-	-	1	2	1	4	2	1	-	3	4	3	-	-	3	1	25	14.6
Sci + Lang Arts																	
Pre-	7	6	4	6	5	5	8	1	4	6	4	11	6	5	6	84	32.7
Post-	5	5	2	5	5	3	6	3	4	6	4	7	4	5	4	68	39.8
Sci+ Soc Stud																	
Pre-	5	8	5	8	7	9	6	4	10	9	6	5	9	9	6	106	41.2
Post-	1	10	6	2	6	6	4	2	6	1	2	3	6	4	5	64	37.4
Sci + Art, Music																	
Pre-	1	1	1	2	3	1	-	-	-	-	-	1	-	2	1	13	5.1
Post-	-	-	-	-	1	1	-	-	1	-	-	-	-	1	-	4	2.6
Sci + Health																	
Pre-	2	1	1	1	2	1	2	1	2	-	1	1	2	-	-	17	6.6
Post-	1	2	1	1	-	-	-	1	1	1	-	1	1	-	-	10	5.8

remaining 45 persons (30 per cent) combined science with instruction in several other areas.

Teacher-participants were asked to enumerate other (than teaching) special responsibilities relating to science in their schools. The intent of this question was an attempt to ascertain any changes in utilization of teachers as a result of their NDEA Institute training. This question about science responsibilities was somewhat ambiguous; as noted, some respondents tended to misunderstand the question and described duties other than science responsibilities.

About eighty-seven per cent, 186, of the respondents to this item on the Checklist said that during 1965-66 they had no other science responsibilities. Twenty-six persons indicated that they had other science responsibilities, including seven OTP's and eight persons who taught reading, drama, art, as well as a dental hygienist, etc. The responsibilities of these 26 participants included ordering and maintaining supplies and materials, serving on the Science Committee, helping the science fair and preparing audio-visual aids and projects.

During the year after the Institute approximately 83 per cent of the 153 respondents to this item indicated that they had no other science responsibilities. About 17 per cent, 26 persons, indicated that they had other science responsibilities similar to those described above. (Of these, four described other than science responsibilities). Thirteen of the 26 teachers were new, acquiring these responsibilities after the NDEA Institute. This substantiates again our impression on that effective use was being made of these NDEA trained teachers.

The teacher-participants were asked to describe the adequacy of their schools' science materials, the effectiveness of class science field trips, experiments and supplementary teaching aids, and the level of pupil interest in science. (Analysis of the effectiveness of field trips, experiments and teaching aids will not be included in this report.) Table 11 summarizes the percentage of respondents in each of the 15 groups rating their schools' science materials as very adequate, adequate and less than adequate, for 1965-66 and again for 1966-67.

Although the groups differ in the number of schools represented, it was decided to discount this since we were interested in changes in teachers' perceptions, and not necessarily in actual changes in science materials. It can be hypothesized that additional training and interest in science may lead to dissatisfactions about materials and supplies previously considered adequate.

Sixty-seven per cent of the total combined group of respondents (Checklist I) felt that their schools' science materials was "adequate," about 11 per cent described the materials as "very adequate", and 22 per cent as "less than adequate". In four groups, 05, 11, 12 and 15 no participant felt that the materials were more than "adequate", while one third of group 06 described their materials as very adequate. More than nine-tenths of the participants in group 12 rated their materials as being less than adequate. (See Table 11.)

Table 11

Percentage of Teacher-Participants, by groups, expressing Satisfaction with Schools' Science Materials

Group	1965-66 Very Adequate	Adequate	Less Than Adequate	Total N Respondents	1966-67 Very Adequate	Adequate	Less than Adequate	Total N Respondents
01	12.5	81.2	6.3	16	-	77.8	22.2	9*
02	26.7	60.0	13.3	15	15.4	69.2	15.4	13*
03	30.0	60.0	10.0	10	11.1	77.8	11.1	9
04	6.7	73.3	20.0	15	7.4	46.3	46.3	13
05	-	81.2	18.8	16	14.3	64.3	21.4	14
06	33.3	66.7	-	12	50.0	50.0	-	8*
07	13.3	73.3	13.3	15*	8.3	83.3	8.3	12*
08	12.5	37.5	50.0	8*	20.0	60.0	20.0	5*
09	6.7	66.6	26.7	15	10.0	70.0	20.0	10*
10	15.4	76.9	7.7	13*	20.0	60.0	20.0	10
11	-	57.1	42.9	14	-	25.0	75.0	8*
12	-	6.7	93.3	15	-	78.6	21.4	14
13	8.3	75.0	16.7	12	-	50.0	50.0	6
14	6.7	73.3	20.0	15	12.5	75.0	12.5	8*
15	-	100.0	-	15	-	44.4	55.6	9*
Total	10.7	67.0	22.3	206	10.8	63.5	25.7	148

* Not all Checklist respondents in these groups completed this item.

When asked to rate their schools' science materials after the Institute, the distribution of responses for the total remained about the same: approximately 11 per cent rated the materials "very adequate," 64 per cent rated them "adequate", and 26 per cent rated their schools' science materials as "less than adequate".

There were differences in group ratings. For groups 01, 04, 11, 13 and 15 the materials seem to have gotten "less adequate", while for groups 05, 08, 09, 12 and 14 the materials were rated somewhat more adequately after the Institute. If we assume that the materials themselves did not change appreciably, how can these differences be accounted for?

We can postulate that the participants, on the one hand, became more critical of materials previously considered adequate enough, and on the other hand, they became more appreciative and aware of the potentials of the materials previously considered merely adequate.

Teacher-participants were asked to rate the level of interest in, and receptiveness to science of the pupils in their class. Ratings were made on a five-point scale, where 1 = uninterested, 2 = indifferent, 3 = neutral, 4 = interested and 5 = avidly interested. The percentages of respondents, in each of 15 groups, making each rating are summarized in Table 12. Pre and post-Institute ratings are presented as well as the groups' mean rating of level of pupil interest in science.

During the school year 1965-66 teachers rated the pupils as "3.8", being "interested in science." After the Institute, the combined total rating of pupil interest was somewhat greater than "4.0", "interested in science." Initially, three groups, 01, 03 and 12, rated their pupils 4.0 or higher. The remaining groups ranged between 3.6 and 3.9. Only one teacher rated the pupils as being "uninterested" in science, while 13 teachers rated their pupils as having an avid interest in science. The rating of "4" or "5" was used by 81 per cent of the respondents.

After the Institute, approximately 83 per cent of the respondents rated pupil interest at "4" or "5" on the scale; however the great shift, accounting for the higher post mean score, was in the increased number of participants using the five-point on the scale. The mean scores for groups 01, 03 and 11 did not change between administrations. Group 14, who initially rated pupil interest at 3.9, later lowered the rating. All other groups rated pupil interest higher after the Institute than they did before the Institute. (It is important to remember that the teachers were rating different groups of pupils the different years, although there is no reason to believe that the nature of the pupil population in a school underwent a significant change.)

We can hypothesize that (1) the degree of interest in science did not change in the two populations rated by the teachers, or (2) that the pupil interest in science did change. If we accept the first hypothesis, we can attribute the better ratings in 1966-67 to a change in teacher perception of pupils. If we accept the second hypothesis that

Table 12
Percentage of Teacher-Participants, by Groups, Ratings of Pupil Interest in Science.

Group	1965-66 Per Cent Rating 1	2	3	4	5	Mean Rating	1966-67 Per Cent Rating 1	2	3	4	5	Mean Rating
01	-	-	6.2	75.0	18.8	4.1	-	-	-	87.5	12.5	4.1
02	-	6.7	13.3	80.0	-	3.7	-	-	-	83.3	16.7	4.2
03	-	-	10.0	70.0	20.0	4.1	-	11.1	11.1	33.3	44.5	4.1
04	-	-	31.2	68.8	-	3.7	-	8.3	16.7	58.3	16.7	3.8
05	-	-	25.0	75.0	-	3.8	-	-	-	71.4	28.6	4.3
06	-	-	33.3	66.7	-	3.7	-	-	14.3	57.1	28.6	4.1
07	-	6.3	12.5	81.2	-	3.8	-	-	16.7	50.0	33.3	4.2
08	-	-	37.5	62.5	-	3.6	-	-	16.7	66.7	16.7	4.0
09	-	-	26.7	73.3	-	3.7	-	-	27.3	63.6	9.1	3.8
10	7.1	7.1	7.1	64.3	14.3	3.7	-	-	-	33.3	66.7	4.7
11	-	7.1	-	85.7	7.1	3.9	-	-	25.0	62.5	12.5	3.9
12	-	6.7	6.7	66.7	20.0	4.0	-	-	21.4	42.9	35.7	4.1
13	-	-	16.7	75.0	8.3	3.9	-	-	16.7	66.7	16.7	4.0
14	-	-	6.7	93.3	-	3.9	-	-	62.5	25.0	12.5	3.5
15	-	-	13.3	80.0	6.7	3.9	-	-	11.1	66.7	22.2	4.1
Total	0.5	2.4	15.8	75.1	6.2	3.8	0.0	1.4	15.2	57.9	25.5	4.1

in 1966-67 pupils were actually more interested in science, and we assume that the nature of the pupil population did not change significantly, we can attribute better interest in science to a change in teacher behavior with regard to science instruction.

Science and the Teacher-Participants

Participants were asked if they felt equipped to teach science as outlined in the school systems' curriculum guide. Their responses, before and after the Institute, are tabulated below in Table 13 (see page 29). About 58 per cent of the total group indicated that in 1965-66 they did not feel equipped to teach science as outlined in the curriculum guide. Thirty-five per cent of the total group did feel equipped to teach science, there was no response from about seven per cent of the group. One year later, after the Institute experience, 82 per cent of the total group indicated that they felt equipped to teach science as outlined in the curriculum guide. Only six per cent of the group did not as yet feel equipped to teach science.

It is interesting to note differences between the 15 groups. Initially, there were some participants in each group, ranging from 20 to 89 per cent indicating feelings of not being equipped to teach science. After the Institute there were nine groups where not one participant rated herself as not equipped to teach science; only in six groups were there participants who did not feel equipped for science teaching as outlined in the curriculum guide. In another section of the Checklist, several participants commented that they were not comfortable any longer in teaching science as outlined in the curriculum guide; they described these guides as inadequate, and not process-centered.

Since we had anticipated a number of teachers expressing general feelings of not being equipped to teach science, we included in the Checklists additional inquiries into specific areas of content and technique. Participants were asked to rate themselves on their:

"Ability to examine trade books and select appropriate and pertinent concepts."
"Ability to plan simple science experiences for their pupils."
"Adeptness at designing and making simple materials, models, etc."
"Technical ability to use simple instruments and equipment."
"Ability to evaluate the extent to which their pupils have mastered a concept."
"Knowledge of the physical sciences."
"Knowledge of the earth sciences."
"Knowledge of the biological sciences."

The average ratings for each group and for the combined total are presented in Table 14 (see page 31). Mean scores obtained before the Institute tend to range around the mid-point of the five-point rating scale. For the total group the average rating on "ability to examine trade books and select pertinent and appropriate concepts" was 2.8. The highest mean rating (3.2) was on the item dealing with the parti-

Table 13

Percentage of teacher-participants, by groups, who felt equipped to teach science

Group	1965-66 Equipped to teach science	1965-66 Not equipped to teach science	1965-66 No Response	1966-67 Equipped to teach science	1966-67 Not equipped to teach science	1966-67 No Response
01	31.2	50.0	18.8	80.0	-	20.0
02	33.3	66.7	-	92.9	-	7.1
03	20.0	70.0	10.0	77.8	-	22.2
04	25.0	62.5	12.5	92.3	7.7	-
05	12.5	81.2	6.2	100.0	-	-
06	25.0	66.7	8.3	88.9	11.1	-
07	31.2	68.8	-	92.3	-	7.7
08	36.4	36.4	27.2	37.5	25.0	37.5
09	66.7	33.3	-	63.6	18.2	18.2
10	42.9	42.9	14.2	70.0	-	30.0
11	50.0	50.0	-	77.8	11.1	11.1
12	80.0	20.0	-	78.6	14.3	7.1
13	33.3	66.7	-	100.0	-	-
14	6.7	88.7	6.7	80.0	-	20.0
15	26.7	73.3	-	80.0	10.0	10.0
Total	34.9%	58.5%	6.6%	81.9%	6.2%	11.9%

cipants ability to evaluate pupil mastery of a concept; in general, participants rated themselves as having slightly greater than average ability. A pre-Institute mean rating of 3.0 indicated average ability to plan simple science experiences. Participants tended to feel they had somewhat less than average skill in using simple instruments (2.8), and between some and average skill in designing and making materials (2.6). In six of these ratings group 08 had the highest mean and group 12 the lowest mean scores.

Pre-Institute ratings of scientific knowledge - physical, earth and biological science - tended to cluster between "some knowledge" and "average knowledge." For each of the 15 groups, mean ratings on knowledge of biology was higher than the ratings for either knowledge of earth or physical sciences. Other data tend to confirm feelings of greater confidence and competence in biology as compared with physics and earth science.

The same ratings were obtained on Checklist II administered one year later. For the total groups the ratings on each item averaged 3.1, or somewhat more than average. The highest absolute rating of 3.7 was on the two items dealing with participants' ability to design simple experiments and their ability to evaluate the extent to which their pupils have mastered a concept. The greatest absolute increase in mean score were in knowledge of biological and earth science. Participants also tended to feel, after the Institute, that they had somewhat more than average ability to examine trade books and to use simple instruments.

Group 01 rated themselves better on all items, except for ability to design simple materials (no change in mean rating from first to second administration.) The greatest absolute gain for this group was in their ability to use simple instruments and equipment. Group 02, which made great absolute gains between all ratings, indicated the greatest change in their knowledge of earth science, and (relatively) least change in their ability to examine trade books. Group 03 showed the greatest gain in the item dealing with the use of instruments and equipment; prior to the Institute they were the lowest ranking of all groups on this particular item. Groups 04 and 05 indicated that their greatest improvement was in their ability to plan simple experiments; group 04 did not indicate much improvement in the use of instruments and equipment.

For group 06, for example, the greatest absolute gain was in knowledge of earth science; they had the smallest change in ability to examine trade books and select appropriate and pertinent concepts. For group 07 the greatest gain was in knowledge of earth science, as it also was for groups 09, 13, and 14.

For group 08 there were negative changes from the pre and post-Institute ratings. They rated themselves as being poorer in their ability to examine trade books and in their knowledge of the physical sciences. Little positive change was evidenced in their ability to plan simple experiments and to design simple materials. Group 10 on the other hand, indicated large improvement, especially in their ability to evaluate pupil mastery of a scientific concept. Group 11 had

Mean scores of Teacher-Participants, by Groups, on a Science Self-Rating Scale, Administered Before and After the Institute.

Group	Examine Trade Books		Plan Simple Experiments		Design Simple Materials		Use Simple Instruments		Evaluate Pupils		Knowl. of Phys. Sci.		Knowl of Earth Sci.		Knowl of Biol. Sci.	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
01	2.8	3.5	3.1	3.6	2.9	2.9	3.1	3.9	3.6	4.1	2.6	3.2	2.6	3.3	3.1	3.6
02	2.8	3.3	2.9	4.0	2.3	3.2	2.7	3.4	3.1	3.8	2.4	3.4	2.3	3.5	2.9	3.8
03	2.7	3.3	3.0	3.9	2.2	2.9	2.5	3.8	2.8	3.8	2.6	3.2	2.6	3.3	3.0	3.4
04	2.8	3.0	2.8	3.5	2.7	3.1	2.9	3.0	3.2	3.5	2.5	2.7	2.4	2.9	2.8	3.2
05	3.3	3.8	3.2	4.1	2.6	3.1	3.0	3.4	3.4	4.0	2.8	3.4	2.8	3.5	2.9	3.4
06	2.9	3.2	3.1	3.5	2.3	3.0	2.7	3.2	3.1	3.6	2.5	3.0	2.1	3.4	2.8	3.9
07	2.8	3.5	2.9	3.8	2.6	3.2	2.8	3.4	3.1	3.6	2.4	3.3	2.1	3.2	2.8	3.8
08	3.5	3.3	3.6	3.7	3.6	3.7	3.3	3.5	3.3	3.8	2.9	2.8	2.6	2.8	3.5	3.7
09	2.7	3.0	2.9	3.4	2.4	2.7	2.5	3.0	3.1	3.9	2.5	2.9	2.5	3.8	2.8	2.9
10	2.7	3.3	3.0	3.8	2.6	3.2	2.9	3.4	3.3	4.9	2.6	3.1	2.9	3.6	3.0	3.6
11	2.9	3.6	2.9	3.6	2.4	2.8	2.7	3.5	3.1	3.9	2.5	3.1	2.6	3.4	3.0	3.9
12	2.3	3.1	2.7	3.6	1.9	3.1	2.5	3.1	3.1	3.4	2.2	2.6	2.1	3.1	2.7	3.2
13	2.8	3.3	3.0	3.2	2.9	3.2	3.0	3.5	3.0	3.5	2.9	3.0	2.6	3.3	2.9	3.3
14	2.6	2.8	3.1	3.5	2.9	3.2	3.1	3.4	3.2	3.1	2.7	3.1	2.7	3.2	2.9	3.2
15	3.0	3.4	3.0	3.7	2.5	3.3	3.0	3.7	3.0	3.2	2.8	3.1	2.9	3.1	3.1	3.4
Total	2.8	3.3	3.0	3.7	2.6	3.1	2.8	3.4	3.2	3.7	2.6	3.1	2.5	3.3	2.7	3.5

the greatest relative amount of change in their ability to plan simple experiments, while for groups 12 and 15, the area of greatest gain was in their ability to design simple materials.

In addition to these ratings, and as a check on them, participants were asked to specify those science topics or areas they felt best-equipped to teach and most-enjoyed teaching, as well as those areas they felt ill-equipped to teach and least-enjoyed teaching. A content analysis of responses was made. Five broad content categories emerged: biological science, earth science, physical science, social science (miscellaneous) and, teaching techniques. Within each classification several sub-areas were noted. Table 15 (see page 33) presents the frequencies of scorable comments by content area and the percentage that were described as best equipped-most enjoy and least equipped-least enjoy teaching. Although there were group differences, the results are presented for all groups combined.

Of the total 912 scoreable comments obtained on the pre-Institute administration, 342 or 37.5 per cent were categorized as physical sciences, 291 (31.9 per cent) as earth science, and 196 or 21.5 per cent as biological science. There seems to be an inverse relationship between the frequency of response in these three general areas and the percentage of "discomfort" responses: over eighty per cent of the biology responses were "comfortable" as compared with 55 per cent of the earth science responses and 51 per cent of the physical science responses.

In addition to the knowledge content areas, there were some 44 responses that seemed to fall in a technique category. These included statements about using materials and instruments, conducting discussions and leading observations, experimentation and small group work. More than three-quarters of these comments fell under the ill-equipped and least enjoy column. More than 90 per cent of the comments about using instruments indicated discomfort.

There were several items that seem to be related to the social sciences: transportation, communication, and clothing and shelter. Participants were fairly comfortable in this area; about 60 per cent of the responses were of the best equipped-most enjoy kind. (Although the Checklists provided separate questions and spaces for describing topics and areas most enjoy and topics and areas best equipped to teach, as well as least enjoy and ill-equipped to teach, responses were grouped as indicated above. The rationale for combining them is that in just about every instance there was no difference in topics listed as best equipped and those listed as most enjoy teaching.)

On the second administration of the Checklist there were fewer respondents (as already noted) and fewer responses to this item. There was only a total of 457 scoreable comments, just about half as many as obtained in the first administration. Of these, 189, about 41 per cent, were categorized under physical science, about 29 per cent earth science and approximately 23 per cent under biological science.

33a.

Table 15

Frequencies of Comments for the Total Group of Participants Describing Science Areas They Felt Best-Equipped, Least-Equipped to Teach

	1965-66					1966-67				
Content Categories	Total Scoreable Comments	Best Equipped N	Best Equipped %	Ill Equipped N	Ill Equipped %	Total Scoreable Comments	Best Equipped N	Best Equipped %	Ill Equipped N	Ill Equipped %
Biological Sci										
Total	(196)	(161)	(82.1)	(35)	(17.9)	(107)	(89)	(83.2)	(18)	(16.8)
Living Things	191	157	82.2	34	17.8	103	86	83.5	17	16.5
Nutrition, Health	5	4	80.0	1	20.0	4	3	75.0	1	25.0
Earth Science										
Total	(291)	(160)	(55.0)	(131)	(45.0)	(131)	(84)	(64.1)	(47)	(35.9)
Earth Resources	92	51	55.4	41	44.6	35	15	42.9	20	57.1
Space, Planets	97	44	45.4	53	54.6	57	43	75.4	14	24.6
Weather, Seasons	102	65	63.7	37	36.3	39	26	66.7	13	33.3
Physical Science										
Total	(342)	(175)	(51.2)	(167)	(48.8)	(189)	(111)	(58.7)	(78)	(41.3)
Air	15	8	53.3	7	46.7	8	8	100.0	0	-
Shadows	4	3	75.0	1	25.0	3	2	66.7	1	33.3
Electricity	104	44	42.3	60	57.7	47	27	57.4	20	42.6
Motors, Machines	10	3	30.0	7	70.0	8	4	50.0	4	50.0
Sound, Light	45	34	75.6	11	24.4	21	17	81.0	4	19.0
Motion, Force	37	16	43.2	21	56.8	17	5	29.4	12	70.6
Physics	35	8	22.9	27	77.1	28	9	32.1	19	67.9
Magnetism	72	54	75.0	18	25.0	41	32	78.0	9	22.0
Chemistry	16	3	18.8	13	81.2	5	1	25.0	4	75.0
Heat	1	0	-	1	100.0	10	6	60.0	4	40.0
Toys	1	1	100.0	0	-	0-	0	-	0	-
Gravity	2	1	50.0	1	50.0	1	0	-	1	100.0
Misc. (Social Sci)										
Total	(39)	(23)	(59.0)	(16)	(41.0)	(13)	(8)	(61.5)	(5)	(38.5)
Transportation	23	14	60.9	9	39.1	6	3	50.0	3	50.0
Communication	15	8	53.3	7	46.7	4	3	75.0	1	25.0
Clothing, Shelter	1	1	100.0	0	-	3	2	66.7	1	33.3

Table 15 cont'd.

Content Categories	1965-66 Total Scoreable Comments	1965-66 Best Equipped N	1965-66 Best Equipped %	1965-66 Ill Equipped N	1965-66 Ill Equipped %	1966-67 Total Scoreable Comments	1966-67 Best Equipped N	1966-67 Best Equipped %	1966-67 Ill Equipped N	1966-67 Ill Equipped %
Techniques										
Total	(44)	(10)	(22.7)	(34)	(77.3)	(17)	(14)	(82.4)	(3)	(17.6)
Using Materials	5	3	60.0	2	40.0	1	1	100.0	0	-
Using Instruments	15	1	6.7	14	93.3	7	7	100.0	0	-
Discussion, Lecture	2	2	100.0	0	-	1	0	-	1	100.0
Procedures	5	2	40.0	3	60.0	0	0	-	0	-
Observation	1	1	100.0	0	-	3	2	66.7	1	33.3
Experimentation	3	1	7.7	12	92.3	5	4	80.0	1	20.0
Small Group Work	3	0	-	3	100.0	0	0	-	0	-
Total Comments	912	529	58.0%	383	42.0%	457	306	67.0%	151	33.0%

There was no change in the percentage of comments describing their comfort with "living things". The increase in percentage of comments about being ill-equipped to teach "nutrition, health" may be due in large part to this area being neglected during the summer experience.

A slightly greater percentage of the positive comments about Earth Science indicated somewhat greater comfort with this area as a result of the Institute, especially as regards astronomy, - the planets and space.

A greater proportion of responses of the best-equipped, most enjoy type (as compared with the pre-Institue proportion) indicate that participants felt somewhat more at ease with the physical sciences, especially, heat, motors and machines and air.

Interestingly, in only three cases was there a greater number of total scoreable responses in the second administration as compared with the first - heat, clothing and shelter, and observation.

The "techniques" category seemed to have undergone the most shift. Before the Institute 23 per cent of these responses indicated that participants felt well-equipped to use materials, instruments, observation, experimentation and small groups. After the Institute, 82 per cent of the comments indicated ease and comfort in all areas with the noteable exception of "discussion, lecture." As hoped, since they were to learn other techniques, participants were not as comfortable with discussion and lecture after the Institute as they were prior to the Institute.

The Institute and the Teacher-Participant

The only official source of knowledge of the formal objectives of the NDEA Institute was contained in the descriptive brochure which the participants received in the Spring of 1966. We were interested in what the participants expected to learn and accomplish (Checklist I) and what they felt they actually learned and accomplished (II) during the workshop.

The rationale for the question was to provide some information about expectations, in order to compare participants' expectations and the expectations (objectives) of the planners of the Institute.

A content analysis of participants' expectations (Checklist I) was made, and is summarized in Table 16 (see page 35.) Each response statement was broken down into its component parts and each part was tallied separately. For example, the statement "I want to learn more science to become an effective teacher" was tallied once under "increase knowledge" and once under "to become a more effective teacher."

The total group combined averaged (total number of comments divided by number of respondents) 3.5 scoreable comments. (See Table 16, page 35.) The range for individual groups was from 2.2 (group 33) to 4.7 (group 11.) There is sufficient evidence to indicate that some groups are consistently more verbal or fluent (quantity) than others.

Table 16

Frequency of Expectations of the Teacher-Participants, by Group

	Groups															Total	
Content Categories:	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	N	%
Apply to the disadvantaged	2	2	1	3	4	-	3	6	2	-	5	2	3	4	2	39	5.32
Increase, knowledge, understanding	11	8	3	9	13	13	13	3	5	11	8	7	10	12	9	135	18.42
Increase biol knowledge	1	1	-	-	2	-	-	-	1	1	2	-	1	1	1	11	1.50
Increase knowledge earth science	3	2	1	-	3	2	2	-	2	3	3	3	3	5	2	34	4.64
Increase knowledge physical science	2	3	1	1	3	-	2	2	1	2	2	4	-	1	2	26	3.55
Learn to interest, motivate pupils	5	3	3	7	5	2	2	3	1	6	4	2	2	9	6	60	8.19
To exploit available materials	6	3	3	3	8	2	6	3	5	7	4	3	4	6	-	63	8.59
Encourage pupils to experiment	1	2	-	-	3	1	3	-	-	-	7	1	2	1	1	22	3.00
To become a more effective teacher	4	5	2	6	4	4	8	2	7	7	7	8	4	8	9	85	11.60
To learn new techniques	3	1	-	-	4	4	-	-	2	-	2	3	-	-	4	23	3.14
Increase interest, ease, confidence	3	3	2	6	2	6	4	-	-	5	4	4	2	6	2	49	6.68
Learn how to question pupils	1	-	-	2	-	-	-	-	-	-	-	-	-	-	-	3	0.41
To learn new experiences for pupils	6	7	1	7	5	2	6	1	4	2	3	5	3	1	1	54	7.37
To learn to build, construct things	1	2	1	-	4	-	3	-	4	2	3	4	-	-	-	24	3.27
To learn to use instruments	1	1	1	3	1	-	1	-	2	2	2	1	2	1	1	19	2.59
To plan lessons	-	2	2	4	1	-	4	1	2	1	5	4	3	-	3	32	4.37
To see demonstrations	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3	0.41
To learn teaching methods	-	2	-	2	5	1	6	4	3	1	4	4	3	2	2	39	5.32
To become an expert	-	-	1	1	-	1	-	-	2	1	-	-	-	1	-	7	0.95
To learn to make slides	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.14
To learn to evaluate pupils	-	-	-	-	-	-	-	-	1	1	1	1	-	-	-	4	0.54
Total N scoreable comments	50	50	22	54	67	38	63	25	45	52	66	56	42	58	45	733	100.0
Average N scoreable comments	3.1	3.3	2.2	3.4	4.2	3.2	3.9	3.1	3.0	3.7	4.7	3.7	3.5	3.9	3.0	3.5	

An almost perfect, .997, rank-order correlation was obtained between average number of scoreable comments per group on this item as compared with average number of scoreable comments on the previously discussed item, "best equipped and least equipped". It would be interesting to carry the comparison further to determine the relationship between "fluency" and gains in scores.

The single most frequent response as indicated in Table 16, was an increase in scientific knowledge and understanding, accounting for over 18 per cent of the total responses. Specific subject areas knowledges were also mentioned frequently - earth science (4.6 per cent of total responses), physical science (3.6 per cent) and biological science (1.5 per cent of total responses.)

The second most frequently mentioned expectation was generalized interest in becoming a more effective teacher. This type of response amounted to 11.6 per cent of the total responses for all 15 groups combined. "Learn to interest and motivate pupils" and "To exploit available materials", followed. accounting respectively for 8.2 per cent and 8.6 per cent of the total responses. About seven per cent of the responses were the anticipation of learning new experiences for pupils and increasing the participants' own interest, ease and confidence with science. Two expectations, learning to teach science to the disadvantaged child and learning new teaching methods, each accounted for over five per cent of the total responses; these categories in particular are not directly included in the objectives of the Institute. In fact, in some ways, all the expectations of the participants seem to be at slight varience with the objectives of the Institute, with the exception perhaps of change in the participants' ability to demonstrate knowledge of the biological, earth and physical sciences. The designers of the Institute planned that the participants gain skills and learn techniques for selecting, evaluating and exploiting - rather than being taught a specific selection, evaluation or exploitation. The difference perhaps can be summarized as the difference between learning (participants' expectations) as compared with learning to learn (Institute's objectives.)

It is interesting to compare participants' expectations with outcomes described by the participants one year later. In the final section of the 1966-67 Checklist, participants were asked to describe what they learned and accomplished through their experiences with the NDEA Institute. They were also queried about special personal (science) strengths and/or weaknesses exploited, or corrected.

In general, participants were most verbal and direct in answering these questions. The range of responses was quite impressive, from wholesale approval to disapproval, from specific suggestions to general effects, from immediate changes to long-range goals and from helpful, informative experiences to vague generalizations. As anticipated there was a small group of respondents who indicated that "the experience was a total bore", "it was totally worthless", "I learned how not to get parking tickets", or "it was wonderful", "I didn't miss a single day even though I was sick", "I am eternally grateful for the experience" and "it should continue forever and everyone should be a participant."

On the other hand, there were a list of specific comments and accomplishments mentioned. These included such diverse things as "biology good, physics bad", "physics good, earth science bad", etc., as well as, "I learned how to use audio-visual equipment", "I learned how to use a microscope", "I learned about hot and cold experiments", and "about snakes" etc. Also there was another type of response that may be described as rather generalized: "Information in all areas increased", "learned new methods", "learned how to demonstrate", "didn't learn enough information", etc.

As anticipated there were individual differences and some differences that appear to be characteristic of groups. There were surprisingly few indiscriminant feelings and comments. The generalized remarks included suggestions to group homogeneously (group 05, 01), use qualified instructors (group 01), learned only what "I taught myself - only the individual projects were good"(group 03, 01, 07), learned "little or nothing", "didn't learn to teach better" (group 08, 13). With the exceptions of the respondents in groups 02, 10, 11, 14 and 15, there was at least one participant in all other groups who may be characterized as generally dissatisfied with the experience as a totality.

The positive comments were much more interesting. Each group, without exception, mentioned having increased their knowledge about science information in general and about biological science in particular. Most groups also discussed teaching science, some saying they learned how to teach more effectively - (better able to teach what is appropriate to a specific grade level, more flexibility in teaching science, learned how to interest pupils, learned to plan a good lesson, learned to give good demonstrations, learned how to discuss science, etc) - and some saying that they did not learn how to teach science better, that the Institute was not successful in changing teaching methods, etc.

They also discussed, pro and con, but primarily favorable, the new materials presented to them and more importantly, learning sources of materials. One or two comments indicated that there were instances during the school year where participants constructed their own materials; one person mentioned developing a bibliography of science readings for children during the 1966-67 year. Most of the persons who commented about learning how to use equipment reacted favorably. There were three or four comments indicating that the teachers trained in the Summer of 1966 were helping other teachersin their schools, who had not had the NDEA experience with experiments, demonstrations and specific suggestions on how to teach science.

The most important changes were changes in confidence, attitudes, interests and enthusiasms, a decrease in fear, an increase in curiosity, better ability to exploit everyday and natural phenomenon, a change in pupil participation, an appreciation of science as both a philosophy and as an approach, more individualized experiences for children and interest in current scientific theories, etc.

Without exception, every group and most if not all of the participants in every group mentioned greater feelings of confidence with scientific theories, with materials, with instruments and with ideas as a direct result of the Institute. Some of the comments included "I now teach science more often", "I realized that I knew enough science to be able to teach", "I can now present even difficult concepts to children". Many of the comments were generalized and extremely optimistic: "I'm more relaxed, less fearful", "More confident", "my attitude toward science has changed".

More importantly however, was the great number of respondents who spoke about overcoming distaste - notably distaste in handling living things and instruments. One teacher "overcame squeamishness", another increased confidence in working with living things, another spoke about her old fear of trying new things, another spoke about her new "science orientation", others were simply "somewhat more confident, less fearful". One teacher in particular described herself as more "courageous", and another learned how to care for "and love" classroom pets.

With the increased confidence emerged two important results, an increase in curiosity and an awareness on the part of the participants of how children are effected by the teachers' attitude. Several participants indicated that as a direct result of the Institute they were currently engaged in reading and research in specific areas on their own. Some said they were reading science books, one was now subscribing to Science News, several said they themselves learned "how to learn", became "more curious", more "science - minded". In addition there were several comments indicating that some participants learned some scientific theory, were able to coordinate their ideas, got a better grasp of science, cleared up old misconceptions, learned about current advances and learned how to reevaluate their own abilities and limitations. Some spoke of learning that "science was an approach to thinking", others now complained of the limitations of existing curriculum guides.

There were several instances where teachers noted an increase in pupil ability to handle living things as a result of the teacher overcoming her own distaste; some said that they "learned that children can learn"; another "learned that the attitude of the teacher influences the children", and that "teachers' attitude can make science interesting".

There were many mentions of being able to involve and interest pupils, of learning specific things (demonstrations, experiments, etc.) that children responded to, of learning effective ways to present science to children - especially young children. There were a few discoveries; one participant was surprised at her prior underestimation of her pupils' ability to deal with scientific concepts, while another mentioned that she now realizes how much children can learn. Other participants spoke about being able to more adequately evaluate how well a child is learning.

Of great value to the participants was the realization that there exists all around and all the time, a wealth of natural experiences through which children learn, and how important it is to exploit these phenomena.

The responses about individualized activities and pupil participation indicate satisfaction about one of the most important objectives of the entire experience; there is some data available that indicates that at least some teachers actually will adopt this "technique" to the classroom. Firstly, many teachers spoke about the value of pupil participation and individualized experiences as being the single best thing they learned. Some said merely that they learned it, several that they learned how to "get pupils to do it" and others verbally indicated its importance. Some responses were striking however: several teachers said they were more confident in allowing pupils to participate and to experiment, some said that their children now knew "how to observe", all talked about the importance of "Discovery" but some actually said they can make use of the underlying principles and that "discovery works in areas other than science"! A few said that participation was "good for children". Two participants spelled it out in detail - they said that they were able to tolerate, understand and encourage the noise and apparent "chaos" involved in small group work and individualized pupil participation.

RESULTS OF THE SUPERVISOR-PARTICIPANT SCHOOL CHECKLIST

In March-April 1966 and 1967 each of the fifteen supervisor-participants received a School Checklist to be completed as part of the evaluation, for the purpose of providing additional information about the role of science in the schools and more importantly, reflecting any changes in that role as a result of the participants' experience in the NDEA Institute. A copy of the forms used is appended. See Appendix C.

Each supervisor was charged with filling out a separate School Checklist for each of the different schools represented by the teacher-participants in his group. As previously noted (see section describing the fifteen supervisors and supervisory groups), the participants came from 41 different schools. Due to the large number of non-respondents to the teachers' Checklist II, from which school affiliation is determined, it is impossible to accurately determine the number of different schools currently represented by the participants after completing the six week Institute program.

Pre-Institute returns of the School Checklist were completed by nine of the 15 supervisors (by four of the seven assistant principals, two of the three teacher - leaders, and by three of the five coordinators), and covered 18 separate schools. Fewer returns were available for the year following the Institute. Six supervisors (five of the nine who returned School Checklist I and one coordinator who did not complete School Checklist I) returned forms for eight separate schools. For only six of these eight schools was there a pre-Institute rating. Results will be presented separately for each of the six schools for which pre - and post - ratings are available.

One coordinator indicated no difference in weekly time alloted to science instruction and no difference in the amount of time spent in teaching science. This school had had a state-certified librarian and there was no change in the percentage of science books in the library. Prior to the Institute, an OTP comprised the primary science program; after the Institute, the materials introduced in the workshop were widely used throughout the school. The science storage closet developed into science storage "areas." Pre-Institute there were enough supplies, materials and equipment for individual pupil experiences - after the Institute there was no longer enough. Level of interest in science in this school, as rated by the coordinator, changed from "average" to "above average interest in science." The NDEA trained teachers, in particular, had a greater interest in science.

A teacher-leader, in describing his school, indicated that although the current weekly time allotment for science is less than the time alloted prior to the Institute, the time spent in teaching science is left largely to the teachers' discretion. There was no change in percentage of science books in the school library although the school now has a state-certified librarian. There is currently and had been, a special science closet to store materials - materials enough to allow for individual pupil experiences. Before the Institute there was less than average interest in science in the school and a heavy emphasis on reading achievement; as a result of the Institute there is a Science Fair and the level of interest in science has improved.

One Assistant Principal completed School Checklists for one school. He describes the greatest over-all changes, and ascribes the changes directly to the Summer Science Institute. Before the program in this school there was a science OTP; during the current year all five of the teacher-participants from this school are science cluster teachers doing most of the science teaching. The year before the Institute, science supplies, materials and equipment were kept in three closets; they now have a special science room. Most of the teachers, before the Institute, were "fearful of teaching science, taught little science," and as a result there was somewhat less than average interest in science in the school. The school is now described as "science oriented" and each class meets for at least two sessions a week with the science specialists. The most telling feature however, noted by the Assistant Principal, is the presence of live animals and fish in the classroom.

A second coordinator completed two sets of forms for three different schools. He noted an increase in weekly time alloted to science in each of the schools and at each grade level. There was no change however in how science materials were stored or maintained; there was no special room either before or after the Institute in any of these schools. In two schools the percentage of science books in the library increased and there were enough science materials, although children are still not encouraged to work independently. In two schools there had been adequate materials to work with; after the Institute the rating changed - there are not enough materials, supplies and equipment to meet individual pupils' experiences. In general, this coordinator notes little interest in science and insufficient science teaching.

From the sketchy data available and the vague nature of the responses it is difficult to make any definitive statements although one does get the impression that supervisors do not reflect the positive attitudes generally found among the majority of the teacher-participants. In general the supervisors do not see great changes, their attitude is neutral; the teachers, on the other hand, generally express over-all satisfaction and more optimism. While the supervisors tend to limit the more positive aspects to the participants themselves, the participants evidence a greater feeling of change permeating the entire school. Interestingly, the one teacher-leader and the one Assistant Principal who completed the School Checklists saw more widespread benefits than the coordinators; perhaps these people are closer to the school, especially the every-day aspects, and are in a better position to estimate changes.

RESULTS OF THE CLASSROOM OBSERVATION OF THE TEACHER-PARTICIPANTS

Development of the form: After an exhaustive search of the available literature on behavior schedules it was decided to develop our own behavior observation form specifically related to the objectives of this Institute. A copy of the form used in the study is appended. See Appendix J.

The development of the observation schedule underwent several editions, each tried out by the team to use it. Differences in meaning and interpretation were discussed until it was felt that some consensus had been reached. Before the schedule was used in a classroom the two observers rated several Kinnescoped recordings of classroom teaching. At that point we felt that observer agreement was fairly strong; however there were certain biases and disagreements that were not resolved and the final form of the schedule includes many items that reflect individual bias.

The form itself consisted of three pages and mechanically was simple to use. On the first page the observer recorded the name of the teacher, the school, grade and class, the room number, the data and time of the observation, the number of pupils and his initials. Space was provided to indicate how the lesson was introduced and how the aim of the lesson was developed for the pupils. We were interested primarily in three things: (1) pupil understanding of the aim of the lesson, (2) teacher ability to incorporate diverse, familiar experiences, and (3) teacher ability to encourage pupil participation. In fact, (2) and (3) form a basic thread through the design of the schedule, reflecting the Institute's interest in pupil participation and in the "discovery" approach to science instruction; other threads included individualized instruction and emphasis on process-centered activities.

The second page of the instrument stressed the teachers' skill in using a variety of instruments, techniques and materials during different parts of the lesson, her skill in conducting the "experimental" part of the lesson, her working knowledge of the factual basis of the particular lesson and her ability to integrate this lesson with other experiences, both academic and not.

We were concerned with how teachers question their pupils and what they do when a pupil asks a question; items dealing with this type of exchange are grouped on page three of the schedule. We also included some over-all judgmental assessments of the teachers' poise and attitude, as well as the quality of the session and the nature of pupil involvement.

Description of the Sample Observed:

In the proposal for the evaluation of the NDEA Institute, provision was made for classroom observation of the teacher-participants; once before the Institute, once again immediately after the Summer experience and a third observation some time later in the school year.

It was impossible to visit each of the 221 teacher-participants. A sample of three participants in each of 13 groups (we excluded the two groups from outside the New York City system) was selected from among those participants who taught science in grades K-4. Plans were made for three visits to each of the 39 pre-selected participants: Two observers together visited each of the teachers. Supervisors were consulted and a calendar for the first set of observations was prepared. Each participant involved in the observations received a letter informing them of the date of the visit and the intent of the observation; great care was taken to assure them that the observations would be confidential (no one but the evaluators would see the individual observations), that they would not be used to evaluate their performance as teachers, but rather to provide a before and after measure of the effectiveness of the Institute on the classroom performance of the participants. We feel that we did develop their trust; however it should be noted that among New York City teachers there is general dislike of being observed and attendent unease and suspicion.

We had decided to visit three participants in each of the thirteen groups to allow for attrition of subjects during the following year; we also felt that three would provide a fairly good sample on which to base the analysis. We decided also to try to retain the same order of visits for each set of observations; (actually there was a .76 rank-order correlation between the order of the first and second visits) for the third set of observations one member of the two-man team was unable to complete the school visits. This report will deal primarily with the first and second sets of observations.

The pre-Institute observations took place in March-April 1966, and were all completed before the Spring recess; the participants were observed for the second time during September-October 1966 and again during March 1967, approximately one year after the first visit.'

A total of thirty-eight of the selected participants were observed during the first visit; there were two teachers absent, but in one case another teacher volunteered to be observed. Of these 38, 35 were seen by both observers. For the second visit observations of 30 teachers were completed. Of these 30 was included one not seen originally by one of the team members. In other words there were 29 teachers who were observed twice, each time by the two-man observation team: Three of the original 38 had dropped out during the Institute, one transferred to another school, one was on maternity leave, one had become a teacher of music, another was absent and one teacher-participant refused to permit the observation to be conducted. The main body of the results will be based on the two sets of observations of the 29 remaining participants.

Class and Grade Comparisons:

There was considerable change in grade and class assignment between the year before the Institute and the year following the Institute. Only 17 of the 29 participants taught the same grade during the two school years. In addition, four teachers who originally taught self-contained classrooms became cluster teachers, one other was assigned a special reading group, three more went from a higher grade level to a lower grade level, and four from a lower to a higher grade level. (Each of these however, agreed to teach a science lesson for our benefit.) Even among the 17 who remained at the same grade level, five who had taught the highest class on that grade were now teaching the lowest classes, and only nine stayed with the same level.

This reassignment of teachers helped make the before and after comparisons so much more difficult. The observers found it very difficult to compare the behavior of a teacher teaching a bright third grade with her behavior in a very dull and uninterested first grade class. Some further provision for teacher reassignment should be built into the planning of observations; either ask that teachers remain with the same grade for the before and after year, or limit the observations to those who volunteer to stay with the same grade class for the two years involved or thirdly, observe a very much larger sample than necessary and then follow-up those who do remain with the same grade.

Length of Lesson Observed:

There was good agreement between observers on the length of the science lesson observed. In the few cases of disagreement the average time was used as the basis for the following discussion.

The range of time for the first observation was from 16.0 to 44.5 minutes with the majority of the lessons lasting about half an hour. The range of time for the second observations was somewhat longer, from 18.0 minutes to 46.0 minutes. For 12 teachers the second lesson lasted an average of 5.38 minutes longer than the first lesson; for 16 persons the first observation was longer by an average of 5.09 minutes; one person taught the same length lesson both times.

Topic of the Science Lesson

Table 17 (see page 46) summarizes the topic of the lesson taught at the first and second observation. For the pre-Institute observations there were five lessons on sound and vibration, four each on air, living things and magnets and electromagnets. At the second observation, five teachers taught about living things, five taught weather (including thermometers, clothing, etc.) and four taught the use of the magnifying glass. There were 14 different topics the first time and 13 different topics the second time. Only two persons taught the same topic during both the first and second observations, one on electromagnets and one on air (air in water and then plants need air.)

In Checklist I participants were asked to ennumerate those topics they were best-equipped for and most-enjoyed teaching and those for which they were ill-equipped and least-enjoyed. Of the 29 teachers observed, two did not answer this question; eleven of the remaining taught neutral topics the first time (topics not mentioned in either category), ten taught topics they felt best-equipped to teach and six taught topics they did not enjoy teaching. At the second observation, ten taught neutral topics, ten taught topics they originally felt at ease with and seven taught topics they were originally ill-equipped for.

Much more interesting however is the change each individual made from the first to the second observation; seven teachers "improved," i.e., went from a best to an ill-equipped or from a best to a neutral topic. Seven more taught neutral topics during both sets of observations, four teachers taught best-equipped topics both times and three taught ill-equipped topics both times.

Age of topic taught - New topic, young topic, old topic:

We were also interested in whether there was a tendency for teachers - when being observed - to teach a lesson or topic that the pupils were familiar with. For the first observation, 47 per cent of the lessons were new to the pupils and another 47 per cent were "young," already developed topics. There was disagreement about four teachers. The second time there was observer agreement that 45 per cent of the topics were new, 53 per cent young and two per cent of the topics appeared to have been pretty well-developed by the time of the second observation.

In 28 per cent of the cases all teachers taught lessons developed to the same point for the observations. The remaining teachers seemed to present lessons developed to different degrees, indicating perhaps, that they taught more naturally, i.e., they taught whatever they "were up to."

Clarity of Aim:

Ratings from 1 to 5 were made by each of the observers as to how clear (1 = vague, 5 = clear) or vague the aim of the lesson was to the pupils in the class. There was over-all agreement between the observers in 36 per cent of the cases the first time and 28 per cent the second time.

The mean rating of one observer (A) was 4.28; the mean rating for the second observer (B) was 3.28 indicating that he judged the aim as much less clear to the pupils. For the second set of observations, observer (B) had a mean rating of 3.24, slightly lower than his initial rating. Observer (A) had a mean rating of 4.34, somewhat higher than his initial mean rating. For both observers combined the initial mean rating was 3.78; at the time of the second visit the combined average rating was 3.79.

Using the average of the two observers' ratings, seven teachers exhibited no improvement in how clear they made the aim of the lesson to the pupils; nine teachers tended to make the aim more clear the second visit and 13 teachers were rated higher for the first visit than for the second. (For each observer separately the results of individual comparisons differ: for observer (A) there were 11 cases of no change in rating, 8 cases where the aim was less clear the second visit than it was the first visit and 10 cases where, the second time, the aim was more clear to the pupils than it was the first time. For observer (B) there were seven teachers with no change in rating, 12 teachers who were rated lower the second time (more vague) and 10 cases where they were rated hight the second time (more clear).

In general, taking into account observer disagreement, there did not seem to be much change in the teachers' ability to make the aim of the lesson clear to the pupils in the class.

How Aim Was Developed - Imposed to Elicited:

Ratings were made on a 5-point scale where 1 = teacher imposed the aim to 5, teacher elicited the aim from the pupils.

Initially the combined rating averaged 1.59 (observer (A) = 1.93 and observer (B) = 1.24.) For the second set of observations the combined average rating was 2.04. However, observer (A)'s mean rating was 1.84, lower than the initial mean rating, and observer (B)'s mean rating rose dramatically to 2.24. For the first observer (A), there were 11 cases where the rating did not change, 9 cases in which the second rating was lower than the first and 9 cases in which the second rating was higher - more elicited than the first. Observer (B) recorded 12 no change in rating, two cases where the rating was "poorer" (more imposed) the second time and 15 cases received a higher rating the second time. It is difficult to state conclusively the amount, if any, of change in the degree to which the Institute affected the classroom ability of the teacher to elicit the aim of the lesson from the pupils in the class. However, a sub-analysis yields some interesting results: there is a tendency for teachers to elicit the aim of the lesson when she is teaching a topic neutral to her or for which she has indicated that she feels ill-equipped to teach as compared to those topics she feels comfortable teaching. The inverse tendency seemed to obtain after the Institute.

At any rate, even using the highest raters' judgments, the ratings were still low on the scale; after training the teachers were not highly adept at eliciting the aim of the lesson from the pupils.

Table 17

Frequency With Which Teacher-Participants Taught a Content Area During the First and Second Classroom Observations

Topic	First Observation	Second Observation
Sound and Vibration	5	2
Senses (nose)	1	-
Air	4	2
Living things, needs of	4	5
Magnets and electromagnets	4	3
Plants, parts of...seeds	2	1
Properties of water	2	1
Magnifying glasses	-	4
Weather, instruments, clothing, etc.	-	5
Electricity	1	2
Balance	1	-
Friction	1	-
Rocks and sand	1	1
Shadows	1	-
Non-food farm products	1	-
Making butter	1	-
Salt	-	1
Gravity	-	1
Scientific Attitudes	-	1
Total	29	29

Introduction of the Lesson, Topic and Aim:

We were interested in noting how the teacher introduced the lesson, whether she used materials, instruments, textbooks, other printed materials, visual aids or a verbal introduction integrated with the use of any of the materials. We were also interested in whether or not the materials, instruments, etc. were limited to those things found in the classroom or whether she introduced experiences from the home and community.

Observer agreement was generally good. In the first set of observations there was minor disagreement in four instances and in the second set of observations disagreement was limited to three subjects. (In cases of disagreement, an average was devised.)

Table 18 (see page 47) summarizes the introduction of the lesson at both the first and second observations. The most striking aspect of the comparison is the increased diversity in types of introductions used after the Institute experience.

Table 18

Frequency of Types of Introductions Used by the Teacher-Participants, First and Second Observations

How Lesson was Introduced:	First Observation	Second Observation
Use of materials with verbal integration	10	5
Use of materials and visual aids, verbally integrated	2	3
Use of other printed, visual aids, verbally integrated	1	0
Visual aids verbally integrated	7	10
Verbal introduction only	7	6
Other printed material, verbally integrated	2	1
Use of materials, other printed, verbally integrated	0	2
Instruments, visual aids, verbally integrated	0	1
Instruments with verbal integration	0	1

The same increase in variety is noted in Table 19. Before the Institute, 17 of the 29 participants used verbal examples, experiences, materials and aids from the classroom, five more used experiences from the school. Only four and three teachers used home and community experiences respectively. In the lessons after the Institute, 18 teachers used classroom experiences and materials; the remaining teachers used a greater variety of sources than was apparent in the observations conducted prior to the Institute.

Table 19

Frequency of the Use of Examples in the Introduction of the Lesson, First and Second Observations

Source of Materials, Instruments, Examples	First Observation	Second Observation
Classroom	17	18
School	5	0
Classroom and School	0	1
Home	4	0
Community	3	5
Other	0	0
Class and community	0	1
Home and community	0	1
Class, school and community	0	3

The appropriateness of the Introduction was rated on a 5-point scale where a rating of "1" indicated the introduction was inappropriate to the aim and, "5" indicated the introduction was very appropriate to the aim. There was a 66 per cent agreement in ratings between observers.

for the first set, and a 55 per cent agreement for the second set of observations. Using an average of the observers' ratings, the rating of appropriateness was 4.38 initially; immediately after the Institute the combined average rating of appropriateness was 4.16; for each observer separately there was a decrease in average rating from the first to the second observation. For nine teachers there was no change in combined average rating; there were nine teachers whose rating improved in the second observation and 11 whose rating was higher the first time.

There seems some indication that the participants may have sacrificed appropriateness for elaborateness of introduction; it is probable that as the teacher becomes more familiar with the technique there may be a better reconciliation.

Grouping:

Two types of ratings of grouping of pupils were made: (1) whether the children worked as a class, or whether they worked within functional groups, and (2) whether or not the type of grouping used was appropriate to the lesson.

If the classroom had movable tables and the pupils normally sat around tables, (as is the case in most of the primary grade classrooms) this was scored as "whole class" group. Those cases where every child worked independently in his usual seat were also scored as "whole class;" only those situations where grouping was functional to the purpose of the task was a score of "groups" made.

During the first set of observations, 25 of the participants taught "whole class" groups, one arranged a functional group situation and two other teachers combined the whole class and grouped class for different activities. In one instance there was inter-observer disagreement.

At the second observation there were 21 participants who taught the "whole class as a group," four teachers who used functional groups, three teachers who combined both techniques, and one instance of observer disagreement. Looking at the individual performances there were seven participants who changed their method of grouping from the first to the second observation.

In 72 per cent of the ratings of appropriateness of the grouping (first set of observations) the observers agreed; for the second observation there was only agreement in 55 per cent of the cases. Further comparisons were made using the average of the observers' ratings. The mean rating for appropriateness of grouping for the initial observations was 4.09, and for the second set, 4.36. Each of the observers' ratings increased. For 15 teachers the rating was higher the second time as compared with the first, for seven teachers there was no change in rating and for the remaining seven the rating of appropriateness was lower for the second set of observations as compared with the first.

Planning:

In only 19 of the 29 (first) observations did the observers agree on whether the main activity of the lesson was a teacher activity, pupil activity or pupil experiment. Eight were rated as primarily teacher activities (demonstrations, lectures, etc.), eight rated as primarily pupil activities and there were three instances of combined teacher-pupil activities.

For the second set of observations there was disagreement in only six cases; in 19 instances the observers agreed that the primary portion of the lesson was a pupil activity, in one instance it was clearly a pupil experiment; two teachers combined teacher-pupil activity and only one teacher planned a lesson solely around teacher activity.

Pupil Opportunity for Planning:

Pupil opportunity for planning was rated on a scale where "1" indicated no pupil opportunity, "4" indicated much pupil opportunity and "5" indicated too much opportunity allowed pupils in planning the course of the lesson. There was agreement between observers in 76 per cent and 31 per cent of the first and second observations respectively. In only seven of the total of 116 ratings made (four for each of the 29 teachers) was a rating of "3" or higher used, indicating that this item does not discriminate well.

Using the average rating of the observers, the mean score on the first observation was 1.39; the mean score for the second observation was 1.48. Seventeen teachers received a higher rating, i. e., allowed pupils more opportunity to plan, the second time; there were nine teachers whose average rating did not change and three who gave pupils more opportunity to plan before the Institute.

Teachers' Skill in Conducting Planning:

Observer agreement in rating teachers' skill in conducting planning was generally poor; there was agreement in only 21 per cent of the first set and 45 per cent of the second set of observations.

Using the average of the two observers' rating, the combined score was 3.53 and 3.60 for the first and second observations respectively. However, only one observer (B), actually noted an increase in ratings. Based on the averaged observer scores, 12 teachers did not demonstrate any change in skill, nine teachers had higher second ratings, and eight teachers were rated lower the second time as compared with the first.

Pupil Opportunity to Collect Data - Type and Data Collected:

Judgments ranging from "teacher only" to "too much", were made on the opportunity of pupils to collect data and on the type - descriptive or quantitative - of data collected. Agreement was good.

For the first set of observations the combined raters' score was 3.43; on the second set the score was 3.67. Each observer noted an increase.

There were 27 instances of descriptive data and one instance, during the first set of observations, where the data was clearly quantitative.

(There was disagreement in the remaining case.) During the second set of observations there were 28 instances of the collection of descriptive data and one instance in which both descriptive and quantitative data were collected.

Pupil Opportunity to Organize Data Systematically:
Ratings were made on a 5-point scale where "1" indicates that only the teacher organized the data and "5" indicates that pupils had too much opportunity to organize the data. Agreement between observers' ratings were 52 per cent in the first set and 38 per cent in the second set of observations. Both observers noted somewhat increased pupil opportunity during 1966-67; using the combined score the average rating was initially 1.90 - the average rating for the second visits was 2.10.

In the initial observations there were 26 cases where the organization of data was descriptive, one case where data was organized quantitatively and one instance of disagreement. In the post-Institute visit, 26 teachers were rated as organizing the data descriptively, one teacher who combined the descriptive and quantitative organizations, one teacher who made no attempt to organize the data at all, and one instance of rater disagreement.

Interpretation of Data:
The observation schedule allowed the raters to judge who interpreted the data - teacher primarily, pupil primarily or joint interpretation - and whether the interpretation was dogmatic-absolute, probabilistic or inconclusive (not enough information available to make a decision).

In 19 visits the observers agreed that the interpretation was dogmatic-absolute, in three cases they agreed that the interpretation was probabilistic in one case, inconcluscive, and in the remaining cases there was disagreement.

Seventy-seven per cent of the dogmatic interpretations were made by the teacher, 14 per cent by the pupil, and the remaining nine per cent were joint interpretations. Forty-two per cent of the probabilistic ratings were made by the teacher, 42 per cent made primarily by the pupils and 16 per cent resulted from joint interpretations.

In the second set of observations, observers agree that 18 of the interpretations were dogmatic, two were probabilistic and in one case the interpretation was rated as inconclusive.

Fifty-six per cent of the dogmatic interpretations were made by the teacher, 14 per cent by the pupils and 30 per cent were joint interpretations. Of the probabilistic interpretations, 56 per cent were made by the teacher, 33 per cent were joint and 11 per cent of the interpretations were made primarily by pupils.

Teacher Questions:

We were interested in whether the Institute had any effect on the quality and quantity of teacher questions, believing that skilled questioning is a technique intrinsically related to encouraging pupil participation with special relevancy to the discovery approach to teaching.

We included in the instrument two scales, one 5-point scale on frequency of questions asked, and another 5-point scale on the teachers' skill as a question asker. We also noted whether the questions were primarily factual-definitional, explanatory-predictive, or procedural. In addition we indicated whether the purpose of the question was to further the lesson, for evaluation, or an attention-getting, disciplining device.

Since one observer rated teachers' questions as factual-definitional in 81 per cent of the cases observed, agreement between observers occured only when the other observer made the same notation. More importantly, however, observer (B) noted no change in purpose of questions in 17 teachers, and observer (A) noted only 10 teachers whose type of questioning did not seem to change from the first to second set of observations. There was some increase noted in the number of questions rated explanatory-predictive.

Both observers noted an increase in the frequency with which questions were asked during the observations after the Institute. Combined observers' score for the pre-Institute sessions was 3.45, and for the post-Institute sessions, 3.66. Eleven of the individual teachers were rated as questioning their pupils more frequently after the Institute than they did before the Institute.

The teachers were rated as fairly skilled questioners; before the Institute the averaged observer score was 3.86; after the Institute the teachers were rated 3.91. (Observer (A) rated the teachers as more skilled than did observer (B).)

There was observer agreement only in those cases where both observers agreed that the intent of the questions were to further the lesson, primarily because one observer consistently made this type of judgment. The first observer did note an increase in the percentage of questions designed to evaluate pupils' knowledge after the Institute experience.

Teachers' Answers to Pupil Questions:

Teachers were rated on (1) their attitude in answering pupils' questions (from "discourages pupils" to "encourages pupils' questions"); (2) the manner in which they handle questions from pupils (from "pays no attention" to "gets pupils to answer their own questions creatively"), and (3) the degree of teacher tolerance and criticalness with questions (from "intolerant, overly critical" to "overly tolerant, uncritical.")

Agreement between observers ranged from 34 per cent to 69 per cent; in general there was better agreement on the first set of observations.

Initially (combining and averaging observers scores) the mean score on teacher attitude toward questions was 4.19; after the Institute, both raters noted an improvement, the mean score was 4.34. Twelve of the individual teachers were rated better the second time. There was little change in either how teachers handled pupils questions, or their tolerance for questions. In the former instance one observer rated teachers poorer the second time while the other observer tended to rate them higher. The opposite was true in the case of tolerance and criticalness; the combined average score was 3.14 for the first and 3.18 for the second set of observations, both scores reflecting that generally the teachers were very tolerant, appropriately critical.

How Lesson Ends:

There was much better agreement between observers on how the lesson ended. For the first set of observations there were 13 instances of lessons ending with a summary review of the lesson, either on the blackboard, on an oaktag chart and/or in pupils' notebooks. There were five observations which ended in a pupil test, usually a rexographed test reviewing exactly what they had been taught. (In one case there was a test of a scientific concept, using examples and objects not directly taught.) In two instances the lesson ended abruptly; one instance of a homework assignment and another case where plans were made for the next days' session in the library. Seven teachers ended the lesson with a "game", eating butter, drinking Kool-aid, playing instruments, breaking ballons, and drawing or coloring pictures; three of these activities were specifically related to the aim of the lesson.

There was no discernible teacher pattern the second time that could be related to the first set of observations; the manner in which the lesson ends (under conditions of being observed) seems to be dependent on too many other things, e. g., assembly periods, use of clusters, restlessness of class, etc.

In the post-Institute observations there were 14 teachers who gave a summary review, one who gave an oral question and answer test, four abrupt ends, three teachers primarily involved with cleaning up, three teachers who assigned homework and discussed future plans, and four instances of drawing and other games.

Most of the teachers ended the lessons differently both times. In general the differences represented improvements, i.e., from a terminal ending to a homework assignment or from a homework assignment to discussion of plans for the next science activity.

Both raters generally agreed that in ending the lesson the teachers tended to answer the original questions. In general, most teachers who initially answered the original question continued to do so after the Institute.

Both raters were in agreement that the majority of the teachers did not raise new questions in ending the lesson; the first observation there were only eight instances where the observers agreed that she did. While for the second observation, raters agreed that 10 teachers did raise new questions.

Over-All Ratings:

Teachers were fairly poised when they were visited initially; one observer rated them as confident, the other as somewhat more than "at ease." There was agreement in 59 per cent of the ratings. Both raters noted a slight increase in poise for the second visit and agreed on the rating in 62 per cent of the cases.

The teachers' attitude underwent somewhat of a decline; this was noted by both observers. Initially their mean score was 4.26, more than "good." On the post-Institue observations the mean score was 4.22.

Initially, the quality of the session was 3.45, between "good" and "very good"; most teachers taught a better session the second time - the mean score (combined for both raters) was 3.79, almost, "very good".

As for pupil involvement, there was generally high inter-rater agreement. The mean score on the first set of observations was 4.12, on the second set of observations, 4.22. Most teachers were rated as improved in their ability to involve their pupils.

The above analyses of classroom observations of the group of 29 teacher-participants seen prior to the Institute and again immediately after the Summer experience do not adequately reflect the flavor and character of the observations.

In general we were well received; although most of the participants if asked, would probably prefer not having been observed, they welcomed us graciously, and the majority of them were very much at ease. We saw fairly good science lessons being taught; of course, the good teachers were good before the Institute. In the less adequate teachers, there was always some improvement, either in the scope of the lesson and the variety of the experiences presented to the pupils, or in their skill in organizing and planning. Several teachers who initially tried to do too much, too many activities, afterwards were able to simplify and direct the lesson. The strongest over-all impression was a change in teacher willingness to experiment as noted in the greater variety of activities, contents of the lesson, as well as a general feeling that teachers were more flexible.

Comparisons were difficult to make because of the reassignment of teachers described above, and the fact that the 29 participants seen twice may be biased in favor of being a more cooperative group than the 39 selected or of the group of 221.

Certain behaviors, when summarized for observers, did not change much, although in each and every instance some individual teachers did change. Whether these represent no real changes cannot be determined because we saw a rather small segment of behavior. We can characterize these behaviors as the general teaching behaviors, unrelated to science teaching. For example, there was little over-all change in teachers' ability to put across the aim of the lesson, although there was slight improvement reflecting their attempt not to impose the aim on the pupils. In general, neither before nor after the Institute, were teacher particularly successful in allowing pupils to participate in the planning of the lesson, teachers' skill in planning was not significantly changed; however, observer impression does not support this - we strongly feel that the lessons were better planned the second time although it is extremely probable that the teachers did not spend as much effort on formal planning the Post-Institute sessions.

Teachers were not particularly skilled in any of the areas where pupils were expected to participate - in collecting, organizing and interpreting data for example - nor in the manner of questioning pupils and responding to their questions.

Most changes occurred in the following: after the Institute there was a greater diversity of topics; in examples and experiences introduced during the lesson; a better attempt at having the pupils manipulate materials and providing enough materials for each child's independent use; more attempt at developing and using functional groupings of children in the process of instruction; a slight decrease in the absoluteness of interpretations and an increase in the number of instances where pupils participated in the interpretation of the data. Teachers tended to simplify the lessons, to do fewer different things in the course of one session and to direct the lesson to the specific aim. They were much more able to allow pupils to touch materials, play with materials. The materials became more interesting: live animals instead of models; postage stamps and coins to peer at through the magnifying glass rather than a page from a textbook. Teachers were better able to tolerate confusion, the confusion that seems to exist when all pupils are doing something. Everyone seemed happier.

RESULTS OF THE ELEMENTARY SCIENCE SURVEY

The Elementary Science Survey, developed by Teachers College, Columbia University is an 84 item multiple-choice test originally designed to diagnose science weaknesses and strengths. The test yields eight sub-scores and a total composite score. The subscores are: Astronomy; Nutrition; Earth Science; Machinery; Materials and Energy; Physical Environment; Biological Environment; General Science; Elementary Science. A copy of the Survey is included in Appendix E.

Two additional subscores, an Institute and a Non-Institute subscore, were computed. The 84 items were divided into two groups, (1) those taught in the Institute and (2) those items not directly covered in the Institute curriculum. The breakdown was submitted to the Advisory Committee who agreed on the final decisions. Items # 6, 8, 9, 13, 14, 16, 17, 18, 20-22, 25, 30, 32, 34, 36, 37, 39, 40-42, 44, 50, 53, 54, 58-60, 64, 69, 70, 73, 76 comprise the Institute score, the remainder comprise the Non-Institute score. The highest possible Institute subscore was 33; the highest non-Institute subscore was 51.

The Survey was administered to the teacher-participants as part of the test battery at the beginning of July and again in August after a six-week interval. The same form of the test was used for both administrations. The following analyses are based on the results of those

Table 20

Mean Scores of Total Group of Teacher-Participants on both Administrations of the Elementary Science Survey

Subscore	First Administration M	S.D.	Second Administration M	S.D.	Mean Diff	P
Astronomy	6.05	1.79	6.58	1.78	0.53	.01
Nutrition	5.32	1.17	5.48	1.25	0.16	NS
Earth Science	5.45	2.12	7.26	2.25	1.81	.01
Mach., Mater., Energy	7.23	1.97	7.75	1.96	0.52	.01
Physical Environ.	7.59	2.84	8.67	2.93	1.08	.01
Biological Environ.	5.98	1.82	7.12	2.10	1.14	.01
General Science	6.58	1.53	7.06	1.61	0.48	.01
Elementary Science	12.28	2.94	14.22	3.34	1.94	.01
Total Score	44.86	9.25	50.58	9.94	5.72	.01
Institute Score	17.99	4.30	21.14	4.62	3.15	.01
Non-Institute Score	26.87	5.83	29.44	6.26	2.57	.01

participants, 218, who completed both administrations.

Table 20 (see page 55) summarizes the mean score for the total group of teacher-participants on both administrations. Included in the table are the eight subscores and the two specially devised Institute scores.

All scores, with the exception of the Nuitrition sub-score, were significant at the .01 level of confidence.

Interestingly enough, the mean difference in the Non-Institute score as well as the Institute was highly significant, although the larger standard deviation of the former indicates somewhat greater variability. However, it is important to note that there could not be adequate control over what was, and what was not taught within supervisory groups. It is of course extremely possible that certain groups actually became involved in subjects outside the scope of the perscribed curriculuum. It is expected however that this would have occured on a random basis.

Of the eight sub-tests the greatest mean gain was in Elementary Science, followed by Earth Science, Biological Environment and Physical Environment.

Mean scores and measures of variance were computed for each of the 15 groups for each of the sub-tests as well as for the composite scores. The t-test statistic was computed and the results of these comparisons are presented in Tables 21 through 23.

Tables 21 and 22 summarize the mean score for each group on each sub-test for the first and second administration respectively. Group 11 had the highest initial total score of 50.07 followed by groups 08, 02, 05, 01, 15, 07, 13, 03, 06, 14, 10, 04, 12, and 09 with a mean low score of 40.66, a range of more than nine correct items. On the second administration group 06, gaining an average 18 points, had the highest total mean score, (61.66) and group 09 had the lowest score of 44.00, a range of 22 items. There is a rank-order correlation between groups of .79 on total score for the first and second administration; if it were not for the exceptional final performance of group 06 the correlation would have been much higher.

There is a strong tendency for those groups who score higher on the Institute score to also score high on the Non-Institute score. For the first administration the rank-order correlation was .67; for the second administration the rank-order correlation was .84.

Table 23 summarizes the average gain between administrations for each group on each subtest and the significance of those gains. For this report, any t-test that does not reach the .05 level of confidence is not considered significant (N.S.).

The range in gains on total score is from 18.13 for group 06 to 3.50 for groups 01 and 10. (Note that the gain is significant for group 01 but not for 10). There were two groups, 10 and 11, who did not perform significantly better (total score) on the second administration.

Table 21

Average Scores for Each of the Fifteen Groups of the First Administration of the Elementary Science Survey

Sub-test	C1	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Astronomy	5.72	6.20	6.00	5.82	6.11	6.53	6.12	7.09	5.66	6.00	6.78	5.62	5.50	5.71	6.20
Nutrition	5.50	5.13	6.10	5.11	5.47	5.13	5.31	5.72	4.80	5.25	5.57	4.81	5.41	5.07	5.86
Earth Science	6.05	6.06	5.60	5.05	6.52	4.46	5.06	5.90	4.46	5.00	6.57	4.93	5.83	5.42	4.93
Mach, Mter, Energy	7.66	7.46	7.40	6.82	7.58	7.26	6.87	7.72	6.73	6.75	8.07	6.68	7.08	7.50	7.00
Physical Enviornment	7.83	8.93	6.50	7.35	8.52	7.06	8.50	8.54	6.66	5.75	8.57	6.37	7.50	7.57	7.73
Biological Inviornment	6.22	6.46	6.30	5.35	5.88	6.40	6.00	5.90	5.20	6.00	7.00	5.56	6.00	5.57	6.13
Gen. Sci.	6.72	7.33	6.00	6.11	6.82	6.00	6.75	7.18	6.46	7.33	6.92	6.25	6.66	5.92	6.40
Elemen Science	12.55	13.60	12.30	11.76	12.88	12.13	12.25	13.63	11.00	11.41	13.14	10.75	12.75	12.07	12.40
Total Score	16.38	48.20	44.30	42.05	47.64	43.53	45.18	48.72	40.66	42.75	50.07	40.93	44.50	43.21	45.26
Institute Score	18.94	18.60	18.90	16.76	19.41	17.26	17.18	18.90	15.73	17.16	21.21	16.93	18.00	18.00	17.33
Non-Institute Score	27.44	29.60	25.40	25.29	28.23	26.23	28.00	29.81	24.93	25.58	28.85	24.00	26.50	25.21	27.93

There were many significant gains in Earth Science and Elementary Science; six and five groups had statistically significant results in each sub-score respectively. Only two groups gained significantly in knowledge about Nutrition as compared with three groups in Astronomy and Machinery, Materials and Energy.

There were differences between groups that should be noted: Group 06 showed significant improvement in seven of the eight subtests and group 15 in six of the eight. Groups 03, 05 and 13 showed significant improvement in four of the eight subtests; group 14 and 02 in four of the eight. For groups 01, 04, 07 and 08 there were only three subtests that reflected significant gain, for group 09, two subtests. Groups 10, 11 and 12 each had one statistically significant gain. Note that the three groups led by peer-supervisors, 01, 08 and 11, all showed fairly little significant change in scores. Generally, the groups supervised by coordinators were among the groups making the most significant gains.

In interpreting these results it is of utmost importance to remember that the same form of the test was used in both administrations; there is no information available on the practice effects. In this evaluation in particular, practice effects may be compounded effects because of groups remembering questions and discussing possible responses with the help of the supervisor. We tried to forestall this as much as possible by making certain that all test booklets were returned at the end of the testing session so that direct reference to a specific question was not possible. We can only assume that different groups "recalled" different questions at random so that the effects of using the same form of the test would be somewhat reduced.

RESULTS OF THE TEST OF SCIENCE CONCEPTS

The Test of Science Concepts was specially constructed to evaluate the specific objectives of the Institute in the absence of other existing more relevant instruments. In particular, what was felt was needed was a measure of science understanding and problem-solving ability, and of knowledge in several pre-selected areas of biological, earth and physical science.

It was decided to attempt to construct an instrument that would measure reasoning and problem-solving in science. The traditional reading comprehension tests provided the model - a passage followed by questions about the passage. Two passages in each area of biological, earth and physical sciences were written. The final instrument consisted of a total of six passages each followed by seven questions. The questions, multiple-choice, were based on information contained in the passage; however, in order to arrive at the correct answer one had to deduce it from the information provided. In other words, the "right answer" itself was not directly incorporated in the passage (unlike the reading comprehension test) but all information necessary to determine the correct choice was made available. Another important departure from the standard reading comprehension format was in the untimed administration of this Test of Science Concepts. The six passages in the final version appeared in the following numbered order:

Table 22

Average Scores for Each of the Fifteen Groups on the Second Administration of the Elementary Science Survey

Subtest	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Astronomy	6.22	6.66	6.40	6.35	7.00	7.40	6.18	7.36	6.26	6.25	7.57	5.81	6.58	6.00	6.86
Nutrition	5.50	5.66	5.90	5.58	5.70	5.73	5.31	5.72	4.86	5.58	5.42	4.56	5.33	5.07	6.46
Earth Science	6.66	8.46	7.60	6.05	7.88	9.26	7.43	7.81	6.26	6.16	8.00	5.93	8.00	6.57	7.33
Mach, Mter, Energy	8.00	8.00	7.30	7.70	7.35	9.25	7.75	8.36	6.73	7.00	8.35	7.68	7.16	7.92	7.46
Physical Environment	9.00	8.73	8.40	7.23	8.70	11.50	6.87	9.18	7.06	6.83	9.21	7.18	8.50	9.35	10.06
Biological Environment	7.11	7.06	6.30	6.58	7.11	10.00	6.56	7.72	6.33	6.75	7.92	6.43	7.08	6.35	7.53
Gen. Sci.	6.66	7.73	7.30	6.94	8.00	7.00	6.93	7.00	6.06	7.00	6.92	7.06	6.75	6.21	7.66
Elemen. Science	14.00	15.46	14.10	13.35	13.94	17.06	14.56	16.27	12.00	12.25	13.92	11.62	11.83	14.07	15.60
Total Score	49.88	53.13	49.70	47.29	52.41	61.56	49.50	53.90	44.00	46.25	54.35	45.18	50.08	48.07	53.86
Institute Score	20.94	23.00	20.70	19.41	22.47	24.50	19.75	22.81	18.40	19.83	24.57	18.87	21.41	19.78	21.13
Non-Institute Score	28.94	30.13	29.00	27.88	29.94	37.06	29.75	31.09	25.60	26.41	29.78	26.31	28.66	28.28	32.73

(1) Relative Motion, and (4) Catalysis (earth science); (2) Change of Phase, and (5) F = M x A (physical science); (3) Tropisms, and (6) Food Chains (biological science.) Each passage could be scored separately. Three of the passages, one in each area, (1) relative motion, (2) change of phase and (3) tropisms, comprise the "Institute subscore," and were to be taught in the Institute. The remaining content passages (4), (5) and (6) were not included in the Summer curriculum, and constitute the "Non-Institute subscore." In addition, a total score on the Test of Science Concepts was obtained. A copy of this Instrument can be found in Appendix D.

The Test of Science Concepts was administered to the total group of teacher-participants as part of the beginning and end of Institute test battery. The same form of the test was used. Only the results of those participants who completed both administrations, 218, were used in the analyses which follows.

The highest possible sub-score for each passage was 7.00, the total number of possible correct responses: The highest total score was 42.00.

Table 24 (see page 63) summarizes the scores on both administrations of the Test of Science Concepts for the total group of respondents combined. The total test score for the first administration was 25.10; on the second administration, six weeks later, the mean score was 28.83, a statistically significant gain of 2.34 points.

Taking the average number of correct responses as a rough index of difficulty, the most difficult passage for the participants on the first administration was "Catalysis", followed by "Relative Motion" - the earth science topics. Next in difficulty were "Change of Phase" and "F = M X A", while "Tropisms" was the easiest passage; the entire group averaged 5.34 correct of a possible 7.00 on the Tropism sub-score.

For the total group the "Institute Subscore" (Relative Motion + Change of Phase + Tropisms) was 12.80 as compared with a Non-Institute subscore of 12.29. For the second administration there was a 2.34 gain in the Institute Subscore and a 1.40 gain in the Non-Institute Subscore. Both subscore gains were significant at the .01 level of confidence.

Although all sub-scores for the combined total were significantly higher on the second administration, the greatest absolute increase in score was in Relative Motion (1.43) and Change of Phase (0.75). Tropisms, the third content area comprising the Institute Subscore, exhibited the smallest gain of (0.16); this is most likely due to the very high initial mean score and the restricted variance.

The significant gains in "Catalysis", "F = M X A" and "Food Chains", as well as in Non-Institute subscore may be attributed to any one or combination of the following reasons: (1) The gain may be due simply to practice, test-retest, effects; (2) The gain may represent a true change in learning how to solve all problems in science; (3) The gain may be due to exposure of these unplanned contents within supervisory groups during the course of the Institute. (The gains in Institute Subscore

Table 23

Average Gains and Significance of Gains, Between Both Administrations of the Elementary Science Survey for the Fifteen Groups

Subtest	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Astronomy	0.50	0.46	0.40	0.53	0.89**	0.87	0.06	0.25	0.60	0.25	0.79**	0.19	1.08*	0.29	0.46
Nutrition	0.00	0.56	-0.20	0.47	0.23	0.60**	0.00	0.00	0.06	0.33	-0.15	-0.25	-0.08	0.00	0.60**
Earth Science	0.61	2.40*	2.00**	1.00	1.36*	4.80*	2.37*	1.91**	1.80*	1.16**	1.43	1.00*	2.17*	1.15	2.40*
Mach. Mter, Energy	0.31	0.54	-0.10	0.88**	-0.23	2.00*	0.88**	0.64	0.00	0.25	0.28	1.00	0.08	0.42	0.46
Physical Environment	1.17**	-0.20	1.90**	-0.12	0.18	4.54*	0.37	0.64	0.40	1.08	0.64	0.81	1.08	1.78**	2.33*
Biological Environment	0.89**	0.60	0.00	1.23*	1.23**	3.60*	0.56	1.82**	1.13*	0.75	0.92	0.87	1.08*	0.78	1.40*
Gen. Sci	-0.06	0.43	1.30*	0.83	1.18**	1.60*	0.18	-0.18	-0.40	-0.33	0.00	0.81	0.09	0.29	1.20*
Elemen. Science	1.45**	1.86*	1.80**	1.59**	1.06	5.73*	2.21*	2.64*	1.00	0.84	0.78	0.87	2.08*	2.00**	3.20*
Total Score	3.50*	4.93*	5.40*	5.24*	4.77*	18.13*	4.32*	5.18*	3.74**	3.50	4.28	4.25*	5.58*	4.86*	8.60*
Institute Score	2.00*	4.40*	1.80	2.65*	3.06*	7.34*	2.57*	3.91*	2.67*	2.67**	3.36*	1.94**	3.41*	1.78**	3.80*
Non-Institute Score	1.50	0.53	3.60*	2.59**	1.71	10.80*	1.75**	1.28	0.67	0.83	0.93	2.31**	2.16	3.07**	4.60*

* Significant at the .01 level of confidence
** Significant at the [illegible] level of confidence

may also of course, be due to the same reasons, but because the gains in these scores tend to be greater and for a larger number of individual groups (see Table 27), there is some basis for attributing these to the Institute experiences rather than to testing procedures.)

Tables 25 and 26 (see page 64) summarize the mean score on each subtest for each of the 15 groups on the first and second administration respectively, of the Test of Science Concepts. Group 11 had the highest total score, 29.35, on the first administration, followed by groups 05, 15, 02, 08, and 13. Groups 12, 14, 09, 10, and 03 were the poorest performing groups on the first administration. There is a .94 rank-order correlation between total score and Institute Subscore for the first administration, and a correlation of .85 between Institute and Non-Institute subscore, indicating that some groups to start with knew more science than did other groups.

In general the groups retained the same relative position on the second administration of the Test of Science Concepts; the rank-order correlation between Institute-subscore was .76. The greatest shift in relative position was for group 11 who went from highest Institute- subscore on the first administration to eighth highest score on the second.

Table 27 (see page 66) summarizes the mean difference in score between administrations for each of the 15 groups on each of the subtests and the statistical significance of each of the differences. Generally, all groups obtained somewhat higher scores on the second administration: Group 10 increased their total mean scores by 9.58, and group 06 by 7.73 points. Significant increases in total score was also obtained for groups 02 (4.27), 03 (3.80), 05 (2.41), 07 (5.19), 09 (2.13), 12 (1.53), 13 (4.08), 14 (3.66), and group 15 (3.60). With the exception of groups 06, 10 and 15 all groups had a greater gain in Institute subscore than in their Non-Institute subscore. For groups 06 and 10 both subscores showed statistically significant gains at the .01 level of confidence; for group 15 the significant increase was in Institute subscore only.

Eight of the 15 groups showed significant gains in "Relative Motion" and five showed significant gains in "Change of Phase". For the remaining sub-tests there were no more than three groups who gained significantly on each. Comparing the number of groups who averaged better on the Institute subscore with the number of groups who changed significantly on the Non-Institute score, the results are impressive: For thirteen of the 15 groups the growth in average score on the Institute subscore was statistically significant. For only four groups was the increase in Non-Institute subscore statistically significant.

These results would seem to indicate that the Institute was effective in increasing scientific knowledge and problem-solving ability in those areas that formed part of its curriculum. Although there were increases in scores in those science topics not directly covered during the Institute, these increases in general are not significant and may be largely attributed to the test-retest procedure involving the use of the same form of the Test of Science Concepts.

Table 24

Average Scores on Both Administrations of the Test of Science Concepts (Total Group)

Sub-scores	First Administration		Second Administration		Mean Difference	P
	M	SD	M	SD		
Relative Motion	3.25	2.06	4.68	1.95	1.43	.01
Change of Phase	4.20	1.92	4.95	1.86	0.75	.01
Tropisms	5.34	1.21	5.50	1.18	0.16	.05
Catalysis	2.74	1.79	3.41	2.06	0.67	.0[illegible]
F=MxA	4.77	1.64	5.22	1.54	0.45	.01
Food Chains	4.77	1.66	5.04	1.57	0.27	.05
Total Score	25.10	7.07	28.83	6.86	3.73	.01
Institute Score	12.80	3.96	15.14	3.74	2.34	.01
Non-Institute Score	12.29	3.81	13.69	3.92	1.40	.01

Table 25

Average Scores on the First Administration of the Test of Science Concepts

Subscores	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Relative motion	2.72	3.73	2.80	3.11	4.29	3.40	2.87	3.63	2.00	2.41	3.92	3.06	3.83	3.46	3.53
Change of Phase	4.61	4.53	2.80	4.23	4.52	4.80	4.06	4.63	2.93	3.25	5.14	4.20	4.83	2.93	5.13
Tropisms	5.22	5.40	4.70	5.35	5.52	5.06	5.62	5.81	5.06	4.83	6.00	4.80	5.33	5.13	6.06
Catalysis	3.22	2.73	1.60	2.64	3.58	2.26	2.62	3.18	2.53	2.41	3.50	2.60	2.66	2.13	3.00
F = M x A	4.88	5.93	4.10	4.64	4.88	5.00	4.93	5.45	4.06	3.91	5.35	4.66	4.58	4.00	4.93
Food Chains	5.16	5.13	4.30	4.70	5.52	4.40	4.81	4.63	4.33	3.91	5.42	4.20	5.25	4.53	4.93
Total Score	25.83	27.46	20.30	24.70	28.35	24.93	24.93	27.36	20.93	20.75	29.35	23.53	26.50	22.20	27.60
Institute Score	12.55	13.66	10.30	12.70	14.35	13.26	12.56	14.09	10.00	10.50	15.07	12.06	14.00	11.53	14.73
Non-Institute Score	13.27	13.80	10.00	12.00	14.00	11.66	12.37	13.27	10,93	10.25	14.28	11.46	12.50	10.66	12.86

Table 26

Average Scores on the Second Administration of the Test of Science Concepts

Subscores	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Relative motion	3.33	5.93	4.00	4.00	4.88	4.26	5.75	5.90	3.40	6.08	4.42	4.93	5.00	3.93	5.13
Change of Phase	4.77	5.20	3.60	5.00	5.82	6.20	4.87	5.54	3.73	3.75	5.07	4.20	6.08	4.40	5.66
Tropisms	5.72	6.00	5.80	5.17	5.58	5.40	5.50	5.45	4.73	5.25	5.64	5.20	6.00	5.20	6.00
Catalysis	3.66	3.33	1.80	2.52	3.70	5.13	3.93	3.45	2.40	5.41	4.07	3.20	3.08	2.93	2.46
F = M x A	5.00	5.66	4.10	5.47	5.52	5.86	5.31	5.09	4.33	5.33	5.1	4.93	5.33	4.73	6.13
Food Chains	5.50	5.60	4.80	4.82	5.23	5.80	4.75	4.36	4.46	4.50	5.28	4.60	5.08	4.66	5.80
Total Score	28.00	31.73	24.10	27.00	30.76	32.66	30.12	29.81	23.06	30.33	29.64	27.06	30.58	25.86	31.20
Institute Score	13.83	17.13	13.40	14.17	16.29	15.86	16.12	16.90	11.86	15.08	15.14	14.33	17.08	13.53	16.80
Non-Institute Score	14.16	14.60	10.70	12.82	14.47	16.30	14.00	12.90	11.20	15.25	14.50	12.73	13.50	12.33	14.40

Groups that did relatively best on the second administration of the Test of Science Concepts tended to also do better on the second administration of the Elementary Science Survey (rho=.66), but interestingly, there is little relationship for the groups between gains on the Test of Science Concepts and gains on the Elementary Science Survey; those groups that increased their performance most on the Test of Science Concepts were not the same groups that gained most on the Elementary Science Survey. The rho correlation between change was .36. These results have implications about the ceilings and bases of the tests. It would appear more difficult to increase your final score if your initial score was high. Actually, on the Test of Science Concepts there is a high negative rank order correlation, - .88, between initial score and amount of gain; on the Elementary Science Survey there is a positive, but insignificant rho correlation, .22, between initial score and amount of gain.

RESULTS OF THE "MEASURING MEANING" TEST

We had assumed that New York City teachers were approaching the teaching of science with many of the fears, concerns and distastes that were evidenced in the area of mathematics, and as a result did not teach much science, or did not teach science well. We assumed further that a teachers' attitude and understanding of science and scientific processes influenced her behavior in the classroom, her own performance on tests and her general feelings of ease and comfort. We believed that given concrete scientific information, expert support and encouragement and an opportunity for self-experimentation, our participants would evidence both a "change of heart" and a "change of mind."

As noted in the two proceeding sections, the "change of mind" proved easier to measure.

A search of the test literature revealed two tests which purported to measure attitudes toward science, the TOUS Test (Test on Understanding Science) by W. W. Cooley and L. E. Klopfer, and the Facts About Science Test by Glen Stice, et.al. Upon close inspection neither instrument seemed suited to our purpose. The TOUS Test, for example, was a "best answer" test of "general knowledge about science, scientists and the ways in which scientists do their work." It contained questions such as: "John Smith is a very imaginative young person. He may never become a scientist because (a) he would not want to give up his freedom of thought; (b) imaginative people usually become artists and writers; (c) he might like some other field better than science; (d) science is too factual for John."

It was decided to investigate a technique developed by C. E. Osgood and others and published in 1957 in The Measurement of Meaning, Urbana, Ill.: University of Illinois Press. This technique, the "Semantic Differential," seems to measure the meaning of concepts. It has been used in a variety of research studies, from a cross-cultural study to determine the similarity of factors of meaning in different languages to evaluating the public image of commodities.

66.

Table 27

Mean Differences in Scores Between First and Second Administration of the Test of Science Concepts

Subscore	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Relative Motion	0.61	* 2.20	** 1.20	0.89	0.58	0.86	* 2.88	* 2.27	* 1.40	* 3.67	0.50	* 1.87	1.17	0.47	* 1.60
Change of Phase	0.16	0.67	** 0.80	0.77	** 1.30	* 1.40	0.81	0.91	0.80	0.50	0.07	0.0	** 1.25	* 1.47	0.56
Tropisms	0.50	0.60	* 1.10	-0.18	0.06	0.34	-0.12	** -0.36	-0.33	0.42	-0.36	0.40	** 0.67	0.07	-0.06
Catalysis	0.44	0.60	0.20	-0.12	0.12	** 2.87	** 1.31	0.27	-0.13	* 3.00	0.57	0.60	0.42	0.60	-0.54
F = M x A	0.12	-0.27	0.0	0.83	0.64	** 0.86	0.38	0.36	0.27	** 1.42	-0.21	0.27	0.75	0.73	* 1.20
Food Chains	0.34	** 0.47	0.50	0.12	-0.32	** 1.40	-0.06	-0.27	0.13	0.59	-0.14	0.40	-0.17	0.13	** 0.87
Total Score	2.17	* 4.27	* 3.80	2.30	** 2.41	* 7.73	* 5.19	2.45	** 2.13	* 9.58	0.29	* 1.53	** 4.08	* 3.66	** 3.60
Institute Score	** 1.28	* 3.47	* 3.10	1.47	* 1.94	* 2.60	* 3.56	** 1.81	** 1.86	* 4.58	0.07	* 2.27	* 3.08	2.00	** 1.07
Non-Institute Score	0.89	0.80	0.70	0.82	0.47	* 5.14	** 1.63	0.37	0.27	* 5.00	0.22	1.27	1.00	** 1.67	1.54

* Significant at the .01 level of confidence

** Significant at the .05 level of confidence

Osgood used three dominant factors, (I) Evaluative, (II) Potency and (III) Activity, and an equal number of scales for each factor. Below is an example of these factors and some scales representing them:

I. Evaluative: good-bad, kind-cruel, beautiful-ugly;
II. Potency: hard-soft, strong-weak, masculine-feminine;
III. Activity: active-passive, fast-slow, excitable-calm.

Each adjective pair, following Osgood's format, comprises a seven-point bipolar scale. These adjective scales were to be used by each subject to rate a concept that appears on the top of the test booklet. The instructions, as developed by Osgood, asked the respondent to indicate how he felt about the concept in terms of the scales.

Some changes were made in order to more adequately suit this technique to our purposes. The major adaptation was not using the factors of Potency and Activity, which do not appear to have maximum relevance to the concepts we were interested in but retaining the Evaluative factor (there are previous findings that the evaluative factor is the most reliable and also the most valid factor). J. C. Nunnally in a study, Popular Conceptions of Mental Health: Their Development and Change. New York: Holt, Rinehart and Winston, 1961, developed the factor of Understandability which we decided to use.

Ten bipolar scales were selected, five having high loadings on the Evaluative factor and five heavily loaded in the factor identified by Nunnally as an Understandability factor. The scales follow:

Evaluative	Understandability
valuable-worthless	ordered-chaotic
interesting-dull	unpredictable-predictable
important-unimportant	mysterious-understandable
pleasant-unpleasant	complicated-simple
hard-east	familiar-strange

The ordering of scales and the polarity of direction is kept constant for all participants but in the actual administration the ordering of concepts differed. Although the "favorable" sides of some scales are at opposite poles, in the scoring, all the favorable poles of all of the scales were assigned the same score.

Ten concepts were chosen to cover a broad range: These ten concepts were: (1) Scientific Knowledge (2) Myself as a Science Teacher (3) Science Instruments and Materials (4) Scientific Investigations by Pupils (5) My Teaching Skills and Techniques (6) My Elementary School (7) "Difficult" Students (8) Process-Centered Activities (9) Disadvantaged Children, and (10) Individualized Science Activities. A complete sample copy of the instrument and instructions for use are contained in Appendix F.

The semantic differential was administered at the beginning and end of the Institute as part of the battery of tests. The data were hand scored and hand processed. Although Osgood suggests the use of a "generalized distance formula" in the analysis of results, based on the work of Nynnally and others, we decided to use the t-statistic of differences to determine whether or not there were any significant changes in the meanings of the concepts before and after the Institute. The t-tests employed here are based on the same differences in scores used in the generalized distance formula; the later takes into account however, the entire profile produced by the groups.

All analyses were computed for supervisory groups, but results are presented for all groups combined. (Results by groups are available but will not be presented in this report.) Any mean difference in score which does not reach the .05 level of confidence is not considered statistically significant. Only the scores of participants who completed both administrations were used in the analysis of results. A score of 1.0 was used to designate the favorable pole of scale; a score of 7.0 represents the unfavorable pole of the scale. A neutral meaning, or an irrelevant scale meaning, was assigned to the mid-point, 4.0, scale position.

Table 28 (see page 68) presents the results from both administrations of the Semantic Differential, summarized for the combined groups, for both factors and the ten scales. Although the mean difference in scores between administrations are small, each, due to the large number of cases involved, is highly statistically significant at the .001 level of confidence.

The concept, "Difficult Students" received the most unfavorable initial mean rating of almost 4.0; after the Institute experience this particular concept had been changed, but remained the most unfavorable of the ten. On both administrations, "Disadvantaged Children" was the second most unfavorably rated concept. On both the initial and final administration "My Teaching Skills and Techniques" was rated most favorably, although "Science Instruments and Materials" showed the greatest absolute mean change.

"My Elementary School," included as a base concept on which to compare the others, remained as predicted the most stable of the ten concepts, i.e., we did not expect this concept to change: (the mean difference between administration was 0.15).

The next two tables, Tables 29 and 30 present the initial and final mean scores for all groups combined on the Evaluative and Understandability factors respectively. The evaluative factor score is as noted, based on the scores of the valuable-worthless, interesting-dull- important-unimportant, pleasant-unpleasant and hard-easy scales. The Understandability factor score is made up of the remaining scales: ordered-chaotic, unpredictable-predictable, mysterious-understandable, complicated-simple, familiar-strange.

Again, and probably attributable to the large number of cases involved, each concept became statistically more favorable on the total Evaluative factor. See Table 29, page 70. Again the most stable concept was "My Elementary School," with a mean difference of 0.13 (significant at the .01 level).

Table 28

Mean Scores for Each Concept on Both Administrations of the Semantic Differential
(Total Group)

Concepts	Total Initial Mean	Total Final Mean	Mean Difference	P
Scientific Knowledge	2.85	2.51	0.34	.001
Myself as a Science Teacher	2.93	2.38	0.45	.001
Science Instruments and Materials	2.75	2.22	0.53	.001
Scientific Investigations by Pupils	2.82	2.37	0.45	.001
My Teaching Skills and Techniques	2.57	2.21	0.36	.001
My Elementary School	2.77	2.62	0.15	.001
"Difficult" Students	3.99	3.74	0.25	.001
Process-Centered Activities	3.09	2.58	0.51	.001
Disadvantaged Children	3.26	2.98	0.28	.001
Individualized Science Activities	2.79	2.34	0.45	.001
Total-All Concepts	2.89	2.59	0.39	.001

Initially, "Scientific Investigations by Pupils" was the most valuable, most interesting, most important, pleasant and easiest of all concepts -- and it remained as the most favorable concept on the Evaluative factor. "Difficult Students" was the most unfavorable concept at the start of the program, followed by "Process-Centered Activities" and "Myself as a Science Teacher". At the end of the summer, "Difficult Students" was still rated most unfavorably (with the third smallest amount of absolute change in mean score), while "Myself as a Science Teacher" and "Process-Centered Activities" became more favorable in relation to the rest of the concepts. As a matter of fact, both of these concepts showed the greatest absolute of change between administrations.

The concept of "Disadvantaged Children" is worth special consideration. Although the NDEA Institute was organized for teachers of disadvantaged children, the directorate was firmly committed to the position that "children are children" and sound and adequate procedures for teaching science should work as well with all children. However, it is felt that the teacher-participants themselves started out with the position that there "must be special methods, techniques and procedures for teaching the disadvantaged child." During the course of the Institute the participants were never directly instructed in the philosophy of the administration; of course, by implication they were to have come to similar conclusions of their own. After-all, they never received instruction in special techniques for the disadvantaged. However, based on the results of the Effectiveness Rating Scale and the comments in the Checklists, the "neglect" of the disadvantaged was a disappointment to them and they felt that the Institute was ineffective in this area.

The mean scores on the concept of "Disadvantaged Children" clearly reflect this. On the Evaluative factor (all scales), the initial score was 2.54; the absolute change (although significant) was very small, 0.14, and the final mean score was 2.40. This concept ranked sixth most favorable on the first administration and ninth most favorable on the second administration.

Table 30 presents the combined data on the scales comprising the Understandability factor. All mean scores, both initial and final, are higher (more unfavorable) than the comparable scores on the Evaluative factor. And with two exceptions, "Myself as a Science Teacher," and "My Teaching Skills and Techniques," the mean changes in scores between administrations were greater on the Understandability than on the Evaluative factor. Again, all mean differences in score were highly significant.

For the total group, "Difficult Students" was the least understandable of the concepts, both initially and finally. This was followed by "Disadvantaged Children." On both administrations, the concept of "My Teaching Skills and Techniques" was rated most favorably, and "Myself as a Science Teacher" was second most understandable.

Table 29

Mean Evaluative Scores for Each Concept on Both Administration of the Semantic Differential (Total Group)

Concepts	Evaluative-Initial Mean	Evaluative-Final Mean	Mean Difference	P
Scientific Knowledge	2.38	2.07	0.31	.001
Myself as a Science Teacher	2.81	2.19	0.62	.001
Science Instruments and Materials	2.27	1.85	0.42	.001
Scientific Investigations by Pupils	2.11	1.84	0.27	.001
My Teaching Skills and Techniques	2.42	2.02	0.40	.001
My Elementary School	2.47	2.32	0.49	.001
"Difficult" Students	3.44	3.20	0.24	.001
Process-Centered Activities	2.81	2.32	0.49	.001
Disadvantaged Children	2.54	2.40	0.14	.001
Individualized Science Activities	2.24	1.86	0.38	.001
Total Concepts	2.55	2.21	0.34	.001

"My Elementary School" had the smallest absolute change, although it was statistically significant. The greatest absolute change in Understandability was for "Science Instruments and Materials," followed by "Scientific Investigations by Pupils," "Individualized Science Activities" and "Process-Centered Activities." It is interesting that these are the very factors which reflect the primary theoretical foundations of the Institute.

The scores on each of the five separate scales comprising the Evaluative factor is presented in Table 31 for each of the ten concepts.

Initially (and on the final administration as well) "Scientific Investigations by Pupils" was the most valuable of all concepts, and "Myself as a Science Teacher" the least valuable, followed closely by "Difficult Students" and "My Teaching Skills and Techniques." Significant changes in worth were obtained for all concepts except "Science Instruments and Materials" and "Disadvantaged Children." The greatest absolute change along the dimension of valuableness was for "Myself as a Science Teacher" and "My Teaching Skills and Techniques." It is important to note that these are the most personal self-related, of all the concepts.

On the interesting-dull dimension, the participants felt initially that "Scientific Investigations by Pupils" was most interesting, and "Individualized Science Activities" next most interesting of the ten concepts. On the other side, "Process-Centered Activities" and "Myself as a Science Teacher" were both viewed as relatively more dull. By the end of the Institute, "Individualized Science Activities" was rated most interesting and "Difficult Students" least interesting. The changes in mean score for "My Elementary School," "Difficult Students," and "Disadvantaged Children" were not statistically significant; these concepts did not become any more interesting or dull than they had been at the beginning. The relatively greatest absolute mean gains were in the two concepts, "Myself as a Science Teacher" and "My Teaching Skills and Techniques." "Process-Centered Activities," originally most dull, also showed large absolute gains and a shift toward being more interesting.

The changes in the dimension of importance substantiate some of the findings and interpretations. For example, there were no significant changes in importance score for "My Elementary School" (No change expected here), "Scientific Investigations by Children" (originally viewed as the most important), "Difficult Students" and "Disadvantaged Children." The concept of "Disadvantaged Children" actually became more unimportant, although not statistically so, at the end of the Institute -- perhaps reflecting the point of view held by the administration. The changes in "Myself as a Science Teacher" was greatest, followed again by "Process-Centered Activities."

Neither "My Elementary School" nor "Disadvantaged Children" changed significantly on the pleasant-unpleasant continuum. "Difficult Students" started and ended up as the most unpleasant of all concepts. The greatest absolute difference between scores on the initial and final administration was for "Science Instruments and

Table 30

Mean Understandability Scores for Each Concept on Both Administration of the Semantic Differential
(Total Group)

	Understandability Factor			
Concepts	Understandability Initial Mean	Understandability Final Mean	Mean Difference	P
Scientific Knowledge	3.31	2.96	0.35	.001
Myself as a Science Teacher	3.05	2.58	0.47	.001
Science Instruments and Materials	3.23	2.59	0.64	.001
Scientific Investigations by Pupils	3.53	2.91	0.62	.001
My Teaching Skills and Techniques	2.71	2.40	0.31	.001
My Elementary School	3.07	2.90	0.17	.001
"Difficult" Students	4.54	4.29	0.25	.001
Process-Centered Activities	3.36	2.85	0.51	.001
Disadvantaged Children	3.97	3.56	0.41	.001
Individualized Science Activities	3.35	2.82	0.53	.001
Total Concepts	3.41	2.89	0.43	.001

Materials," then for "Process-Centered Activites." "Process-Centered Activities," originally viewed by the participants as fairly valuable, most dull, rather unimportant and unpleasant, became, after the six-week period, somewhat more valuable, more interesting, more important and more pleasant. Again, there were no significant changes in "My Elementary School" and "Disadvantaged Children." By the end of the Institute "Individualized Science Activities" was just about the most pleasant concept of the ten.

The ratings on the scale of hard-easy are interesting. This was the most unfavorable of all dimensions. On this scale, four of the 10 concepts were originally on the unfavorable half of the scale; even after the Institute "Difficult Students" and "Disadvantaged Children" remained distinctively "hard." All mean differences in score, with the exception of "Teaching Skills and Techniques" and "My Elementary School" were statistically significant. The largest absolute difference was in "Science Instruments and Materials" and "Individualized Science Activities." As a matter of fact, by the end of their experience the participants felt that the "Science Instruments and Materials" had become the "easiest" of any of the concepts measured.

Scores on the five scales comprising the Understandability factor are summarized in *Table 32 (see page 75)*. All of these scales are more unfavorable to the participants, both at the beginning and at the end of the Institute, than were the evaluative scales, with the exception of the hard-easy dimension.

As can be seen in Table 32, all changes in mean score on the dimension of order-chaos were significant, including "My Elementary School" and "(Difficult) Students." "Scientific Investigations by Pupils" and "Myself as a Science Teacher" became most ordered, while "'Difficult' Students," "My Elementary School" and "Disadvantaged Children" had the least absolute change. Comparatively, by the end of the Institute, "Scientific Knowledge" and "My Teaching Skills and Techniques" were most well-ordered.

As can be hypothesized, "'Difficult' Students," "Disadvantaged Students" and "Scientific Investigations by Pupils" started out and remained as highly unpredictable (although they all increased in some measure in predicability.) These three concepts are the most other-person concepts as compared to the two previously described as most-personal-related concepts.

"'Difficult' Students" was initially rated as the least understandable concept, while "Myself as a Science Teacher," "My Elementary School," and "My Teaching Skills and Techniques" were most understandable to the teacher-participants. The change for "My Elementary School" was not significant.

On the scale of complicated-simple there was no statistically significant shift for "Scientific Knowledge," "Myself as a Science Teacher," "My Teaching Skills and Techniques" (this concept tended however, to become more unfavorable, i.e., more complicated), "My

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Table 31

Mean Sccres, Both Administrations, for Each Concept on the Scales Comprising the Evaluative Factor of the Semantic Differential (Total Group)

Evaluative Scales

Concept	valuable-worthless Unit Mean	valuable-worthless Final Mean	valuable-worthless Mean Diff	valuable-worthless P	interesting-dull Unit Mean	interesting-dull Final Mean	interesting-dull Mean Diff	interesting-dull P	important-unimportant Unit Mean	important-unimportant Final Mean	important-unimportant Mean Diff	important-unimportant P	pleasant-unpleasant Unit Mean	pleasant-unpleasant Final Mean	pleasant-unpleasant Mean Diff	pleasant-unpleasant P	hard-easy Unit Mean	hard-easy Final mean	hard-easy Mean Diff	hard-easy P
Scientific Knowledge	1.66	1.34	0.32	.001	2.07	1.74	0.33	.001	1.64	1.37	0.27	.001	2.33	2.04	0.29	.001	4.20	3.87	0.33	.01
Myself as a Sci Teacher	2.98	1.96	1.02	.001	2.68	2.02	0.66	.001	2.53	1.86	0.67	.001	2.37	1.91	0.46	.001	3.49	3.19	0.30	.01
Sci Instruments & Mat.	1.44	1.31	0.13	NS	2.10	1.64	0.46	.001	1.59	1.40	0.19	.05	2.49	1.81	0.68	.001	3.76	3.07	0.69	.001
Sci Invest. by Pupils	1.42	1.25	0.17	.02	1.72	1.46	0.26	.001	1.47	1.34	0.13	NS	2.04	1.69	0.35	.001	3.90	3.43	0.47	.001
My Teaching Skills and Techniques	2.38	1.68	0.70	.001	2.39	1.87	0.52	.001	1.87	1.62	0.25	.01	2.21	1.83	0.38	.001	3.25	3.12	0.13	NS
My Elem School	2.09	1.82	0.27	.01	2.30	2.21	0.09	NS	1.88	1.74	0.14	NS	2.32	2.23	0.09	NS	3.76	3.69	0.07	NS
"Difficult" Students	2.69	2.41	0.28	.01	2.45	2.43	0.02	NS	2.29	2.13	0.16	NS	4.31	3.96	0.35	.001	5.46	5.08	0.38	.001
Process-Centered Activities	2.26	1.85	0.41	.001	2.69	2.15	0.54	.001	2.38	2.08	0.30	.01	2.86	2.23	0.63	.001	3.87	3.28	0.59	.001
Disadvan. Children	1.77	1.61	0.13	NS	2.08	1.96	0.12	NS	1.66	1.75	-009	NS	2.58	2.46	0.12	NS	4.64	4.16	0.48	.001
Individual. Sci Activ.	1.56	1.25	0.31	.001	1.86	1.52	0.34	.001	1.63	1.44	0.19	.01	2.09	1.68	0.41	.001	4.05	3.43	0.62	.001
Total Concepts	2.03	1.65	0.38	.001	2.23	1.90	0.33	.001	1.90	1.67	0.23	.001	2.56	2.18	0.38	.001	4.04	3.63	0.41	.001

Table 32

Mean Scores, Both Administrations, for Each Concept on the Scales Comprising the Understandability Factor of the Semantic Differential (Total Group)

Understandability Scales

	Ordered-chaotic				Unpredictable-predictable				Mysterious-understandable				Complicated-simple				Familiar-strange			
Concept	Unit Mean	Final Mean	Mean Diff	P	Unit Mean	Final Mean	Mean Diff	P	Unit Mean	Final Mean	Mean Diff	P	Unit Mean	Final Mean	Mean Diff	P	Unit Mean	Final Mean	Mean Diff	P
Scientific Knowl.	2.25	1.91	0.34	.001	3.15	3.06	0.09	NS	2.89	2.44	0.45	.001	4.65	4.40	0.25	NS	3.62	2.97	0.65	.001
Myself as a Sci Teacher	2.74	2.04	0.70	.001	3.13	2.84	0.29	.01	2.57	2.22	0.35	.001	3.44	3.41	0.03	NS	3.38	2.37	1.01	.001
Sci Instruments & Materials	2.58	2.06	0.52	.001	3.06	2.87	0.19	NS	2.97	2.29	0.68	.001	3.79	3.04	0.75	.001	3.74	2.67	0.07	.001
Sci Investigations by Pupils	3.35	2.54	0.81	.001	3.98	3.57	0.41	.01	2.90	2.34	0.56	.001	3.64	3.13	0.51	.001	3.78	2.95	0.83	.001
My Teaching Skills & Techniques	2.42	1.99	0.43	.001	2.93	2.63	0.30	.01	2.23	1.89	0.34	.001	3.26	3.27	-0.01	NS	2.72	2.23	0.49	.001
My Elemen School	3.23	2.99	0.24	.02	3.37	3.09	0.28	.02	2.56	2.38	0.18	NS	4.05	4.04	0.01	NS	2.12	2.00	0.12	NS
"Difficult" Students	4.88	4.62	0.26	.02	4.98	4.58	0.40	.01	3.61	3.29	0.32	.01	5.76	5.64	0.12	NS	3.46	3.30	0.16	NS
Process-Centered Activities	2.82	2.42	0.40	.001	3.47	3.09	0.38	-.01	2.93	2.42	0.51	.001	3.87	3.36	0.51	.001	3.72	2.96	0.76	.001
Disadvan. Children	4.22	3.83	0.39	.001	4.27	3.72	0.55	.001	2.90	2.51	0.39	.001	5.29	5.01	0.28	.02	3.17	2.72	0.45	.001
Individ. Sci Activ	2.81	2.40	0.41	.001	3.73	3.28	0.45	.001	2.77	2.23	0.54	.001	3.90	3.36	0.54	.001	3.54	2.82	0.72	.001
Total	3.13	2.68	0.45	.001	3.61	3.27	0.34	.001	2.83	2.40	0.43	.001	4.17	3.87	0.30	.001	3.33	2.70	0.63	.001

Elementary School" and "Difficult Students." The greatest absolute (and significant) change was in "Instruments and Materials" which was rated as much more simple on the second administration. This dimension, complicated-strange, produced the most unfavorable ratings of all the Understandability scales.

With the exception again of "My Elementary School" and "'Difficult' Students", all mean differences in scores between administrations were highly significant on the dimension of familiar-strange.

As expected, there was little absolute change in the concept of "Disadvantaged Children." Great amounts of favorable change were found for "Myself as a Science Teacher," "Scientific Investigations by Pupils," and "Process-Centered Activities," all becoming more familiar to the participants. By the end of the Institute "'Difficult' Students" still tended to be somewhat "strange."

In summary, there were greater absolute changes in concepts on the Understandability factor as compared with the Evaluative factor, which in this case seems to tap more of the socially acceptable feelings and beliefs than does the Understandability factor. Initially, scores on the scales comprising the Evaluative factor with the exception of the hard-easy dimension, were more favorable than scores on the Understandability scale. (Post hoc there seems to be some face validity for believing that the hard-easy scale would be more heavily loaded on Understandability; no factor analysis of results has been attempted, so for our purpose the question of loading is academic.)

Putting aside the question of concept, i.e. summarizing over all concepts, the following order reflects the ranking of initial favorableness of the scales themselves: Importance, valuable, interesting, pleasant, understandable, ordered, familiar, predictable, simple and easy. However, there seems to be a negative relationship between initial rating and absolute amount of change; there was most change in the familiar dimension, followed by ordered, understandable, easy, valuable and pleasant, predictable, interesting, simple and important. This may be a result of scale construction where it is more difficult to effect change at the ends of the scale (especially at the positive end, or the end reflecting the desired goal.) This applies equally well to the individual concepts.

As for the concepts themselves, irrespective of factor or scale, the largest absolute change was in "Instruments and Materials," followed by "Process-Centered Activities," "Myself as a Science Teacher" and "Individualized Science Activities," "Teaching Skills and Techniques," "Scientific Knowledge," "Disadvantaged Children," "'Difficult' Students" and "My Elementary School."

"My Elementary School," included primarily to provide a stable base, actually changed very little; it did become more valuable and somewhat more ordered and predictable.

The personal concepts, "Myself as a Science Teacher" and "My Teaching Skills and Techniques" are interesting. In the former concept were the greatest change in feelings of worth and familiarity. Large amounts of change were also apparent in interest, importance and order; lesser changes were in pleasantness, understandability, easiness and predictability. There was no change in complexity. In "My Teaching Skills and Techniques" there were large increases in value and interest, and lesser increases in importance, pleasantness, order, predictability, understandability and familiarity. Small changes occurred in easiness and a nonsignificant "unfavorable" change toward complexity.

There were two concepts considered almost irrelevant to the underlying philosophy of the Institute: "Disadvantaged Children" and "'Difficult' Students." However, "Disadvantaged Children" did become easier, more ordered, predictable, understandable, simple and familiar. Participants did not change their ratings of value, interest, importance and pleasantness. The concept of "'Difficult' Students" did become of more value, became more pleasant, easier, ordered, predictable and understandable, but not more familiar, more simple, more interesting nor more important. In other words these two concepts agreed on the dimensions of ease, order, predictableness and understandability.

The concept of "Scientific Knowledge" changed along all dimensions, except complexity; the greatest absolute change was an increased familiarity with this concept.

The concept of "Scientific Investigations by Pupils" changed significantly on each scale. The greatest absolute changes were in increased order and familiarity.

"Process-Centered Activities" was also significantly more favorably rated on each scale by the end of the Institute. The greatest absolute change was along the dimension of familiarity, pleasantness and ease.

The concept of "Individualized Science Activities" also changed significantly on each scale used. The largest change again was in familiarity, ease, understandability and simplicity.

In general we can feel quite confident that at least along the dimensions we selected and the concepts chosen to be rated, the teacher-participants did experience a "change of heart" during the course of the six-week Summer Institute.

Whether this "change of heart" is temporary or permanent, whether it can be directly attributable to any one factor of the entire curriculum, and whether it will be transferred to actual performance in the classroom are all questions beyond the scope of this report. That is, we are not saying that these questions are of secondary importance; on the contrary -- we believe that any investigations of change in teachers is relatively meaningless unless it can be also demonstrated that these changes in teachers' performance, attitudes and/or knowledge will reach the pupil and be reflected in pupil achievement. The ultimate success of any educational program, whether directed toward parents, teachers or children themselves, must be measurable in terms of the improved achievement of students.

RESULTS OF THE TEACHER PARTICIPANT RATINGS OF THE EFFECTIVENESS OF THE NDEA INSTITUTE

Up to this point we were interested in the effects of the Institute on the participant; we are now interested in securing information about the success of the Institute from the viewpoint of the teacher-participants themselves. In defining success we used the criterion of how well, how effectively, the objectives of the Institute were fulfilled. A statement of objectives had been prepared by the Directors prior to the Institute; these stated goals, expanded and made more specific, provided the basis for Part I of the Teacher-Participant Evaluation of the Effectiveness of the Institute.

Thirty-five statements based on the objectives were developed; these included along with some of the goals, some of the methods and procedures emphasized in the Institute. Each of the statements was to be rated in terms of the degree of effectiveness the Institute demonstrated in meeting the objectives. A four-point rating scale was designed: (1) The Institute has had a NEGATIVE EFFECT on, (2) The Institute has had NO EFFECT on, (3) The Institute has had SOME POSITIVE EFFECT on, and (4) The Institute has had OUTSTANDING POSITIVE EFFECT on ....

Part II of the Instrument consisted of open-ended questions about the future of the Institute, the areas or problems the participants received most-least help with, and suggestions for the improvement of this type of Institute program. A copy of the Evaluation of the Effectiveness is appended. (See Appendix G.)

Part I: Effectiveness of the Objectives of the Institute:

Participants were asked, at the end of the Institute, to complete both parts, the ratings and the open-ended questions. Results were obtained for a total of 220 persons. The data were analyzed separately for each group as well as for all groups combined. A mean score was computed for each of the 35 statments for each of the 15 supervisory groups. Rank orders were computed based on these mean scores.

Table 33 summerizes the mean scores for each item for all groups and for the total group combined. For the total group, the average score fell between a high of 3.44 (between some positive and outstanding positive effect) to a low 2.68 (somewhat between neutral and some positive effect); the median score for the total group of 220 teach-participants was 3.01. For the entire group the highest ranking item was their "enjoyment of science"; the least effectively realized goal was a change in "ability to scan science trade books for appropriate and pertinent concepts."

Group 06 had the highest mean, 3.87, on any one of the items; they were followed by group 10 (3.83), group 03 (3.80), group 07 (3.69), group 09 (3.67), group 08 (3.64), group 02 (3.60), group 05 (3.59), group 14 (3.53), groups 04 and 15 (3.47), group 01 (3.37), group 11 (3.28), group 12 (3.25) and group 13 (3.08). The highest ranked item for the different groups was rated as having been somewhat more than positively effected. The lowest ranking item fell between a mean

Table 33

Mean Scores for Ea. of the 35 Statements of the Effectiveness Ratings for Ea. of the Supervisory Groups

		Groups														
Item	(N=20) Total	(N=19) 01	(N=15) 02	(N=10) 03	(N=17) 04	(N=17) 05	(N=15) 06	(N=16) 07	(N=11) 08	(N=15) 09	(N=13) 10	(N=14) 11	(N=16) 12	(N=12) 13	(N=15) 14	(N=15 15
1	3.18	3.37	3.20	3.10	3.35	3.24	3.67	3.12	2.91	3.07	2.83	3.14	3.06	2.92	3.33	3.07
2	2.93	2.47	3.27	3.30	3.06	3.00	3.40	2.88	2.82	3.13	2.92	2.78	2.94	2.75	2.87	2.47
3	3.15	2.89	2.93	2.90	3.18	3.24	3.47	3.19	3.27	3.13	3.33	3.28	3.12	2.75	3.13	3.40
4	3.17	3.26	3.27	3.10	3.12	3.35	3.73	3.25	2.91	2.87	3.25	3.14	2.69	2.92	3.27	3.27
5	3.11	2.89	3.40	3.40	3.47	2.94	3.73	2.94	2.82	3.20	3.25	3.07	2.81	2.75	3.00	3.07
6	3.38	3.16	3.40	3.60	3.35	3.53	3.20	3.50	3.54	3.67	3.58	3.28	3.19	3.08	3.33	3.47
7	3.28	3.10	3.47	3.70	3.24	3.35	3.07	3.56	3.27	3.00	3.58	3.14	3.25	2.75	3.53	3.33
8	3.11	2.89	3.20	3.50	3.00	3.00	3.00	3.44	3.27	3.00	3.50	2.93	3.00	2.83	3.13	3.20
9	3.01	3.00	3.17	3.30	3.06	3.12	2.87	3.38	3.00	3.07	3.08	2.78	2.56	2.58	3.07	2.87
10	3.06	3.05	3.40	3.40	3.06	3.00	2.93	3.38	3.09	2.93	3.08	3.07	2.75	2.75	3.07	3.00
11	2.97	3.16	3.20	3.40	2.82	2.94	2.93	3.19	3.00	2.87	2.92	2.86	2.75	2.75	2.80	3.07
12	3.04	3.05	3.33	3.60	3.00	2.94	3.00	3.06	3.00	3.00	3.08	2.86	2.94	2.75	3.07	3.07
13	2.84	2.95	2.80	3.40	2.88	2.94	3.13	2.88	2.54	2.67	3.17	2.78	2.44	2.75	2.60	2.87
14	2.68	2.79	2.80	3.20	2.65	2.82	2.93	2.81	2.27	2.53	2.83	2.57	2.31	2.50	2.73	2.47
15	2.84	2.53	3.13	3.00	2.94	2.82	3.53	2.88	2.72	2.73	3.33	2.43	2.62	2.50	2.87	2.67
16	2.97	3.05	3.00	3.30	2.70	3.06	3.13	3.25	3.00	2.93	3.08	2.78	2.75	2.58	3.27	2.73
17	3.32	3.21	3.60	3.80	3.47	3.06	3.27	3.50	3.09	3.33	3.58	3.28	3.12	3.00	3.40	3.13
18	2.89	2.63	2.80	3.20	2.94	2.88	2.80	3.18	3.00	2.80	2.92	3.00	2.62	2.58	3.27	2.87
19	3.04	2.74	3.13	3.50	2.76	3.06	3.13	3.31	3.09	3.13	3.33	2.93	2.81	2.58	3.27	3.13
20	3.05	2.79	3.20	3.20	3.06	3.06	3.13	3.12	3.00	3.07	3.25	2.93	3.06	2.67	3.27	3.00
21	2.95	2.89	3.20	3.20	2.94	3.06	3.13	3.00	3.00	2.80	3.25	2.86	2.69	2.42	3.13	2.80
22	3.01	3.10	3.07	3.60	3.12	2.82	3.07	3.50	2.73	3.00	3.42	2.71	2.88	2.42	2.93	2.87
23	3.03	2.63	3.13	3.70	2.94	3.24	3.13	3.31	2.82	3.13	3.00	2.78	2.81	2.50	3.27	3.13
24	2.97	2.68	3.07	3.30	3.00	3.12	3.20	3.25	2.64	3.07	3.08	2.78	2.94	2.42	3.00	2.93
25	3.18	3.05	3.33	3.50	3.06	3.35	3.40	3.50	3.18	3.07	3.33	2.93	3.00	2.75	2.93	3.40
26	2.97	2.95	3.00	3.20	3.18	3.00	3.00	3.31	3.09	2.80	3.17	2.78	2.75	2.50	2.93	2.87
27	3.01	2.89	2.80	3.30	3.35	3.24	2.93	3.38	3.09	2.80	3.17	2.86	2.94	2.42	3.13	2.80
28	3.01	3.05	3.07	3.40	3.06	3.12	2.87	3.25	2.82	2.93	3.08	2.93	3.00	2.58	3.00	2.93
29	3.08	3.05	3.00	3.40	3.12	2.94	3.53	3.38	3.00	3.20	3.08	2.86	3.00	2.42	3.13	3.07
30	2.87	2.74	3.07	3.00	2.82	2.88	3.07	3.31	2.64	2.87	2.83	2.71	2.81	2.25	3.07	2.80
31	2.83	2.53	3.00	3.20	2.94	2.88	3.07	3.12	2.36	2.87	3.25	2.64	2.69	2.17	2.87	2.80
32	2.78	2.74	2.73	2.80	2.82	2.82	3.00	2.88	2.73	2.80	3.00	2.71	2.75	2.17	2.87	2.73
33	2.84	2.63	3.20	3.10	2.82	2.82	2.87	3.06	2.64	3.00	3.17	2.64	2.62	2.17	3.00	2.87
34	3.44	3.21	3.53	3.80	3.29	3.47	3.87	3.69	3.64	3.33	3.83	3.21	3.00	3.00	3.53	3.47
35	3.36	3.10	3.50	3.50	3.31	3.59	3.53	3.67	3.45	3.21	3.83	3.07	3.19	2.64	3.33	3.47
High Mean	3.44	3.37	3.60	3.80	3.47	3.59	3.87	3.69	3.64	3.67	3.83	3.28	3.25	3.08	3.53	3.47
Low Mean	2.68	2.47	2.73	2.80	2.65	2.82	2.80	2.81	2.27	2.53	2.83	2.43	2.31	2.17	2.60	2.47
Median Sc	3.01	2.95	3.20	3.30	3.06	3.06	3.13	3.25	3.00	3.00	3.17	2.86	2.81	2.58	3.07	3.00

score of 2.17 (group 13) and 2.83 (group 10). It is clearly apparent that there were differences between groups, that certain groups rated all objectives (even the least effectively rated ones) as more successfully realized than other groups. The median of the average scores reflect group differences: group 03 had the highest median score of 3.30, followed by group 07 with a median score of 3.25 and group 02 with a median score of 3.20. Next in descending order were group 10 (3.17), group 06 (3.13), group 14 (3.07), groups 04 and 05 (3.06), groups 08, 15 and 09 (3.00), group 01 (2.95), group 11 (2.86), group 12 (2.81) and group 13 (2.58).

Table 34 presents the rank order of each item determined separately for each group and for the groups combined. A rank of 1 refers to the highest mean, 35 to the lowest mean score. Immediately apparent are the differences between groups; what one group rated as among the 10 most effectively realized objectives was not necessarily what other groups indicated, although there is a surprising aomount of concurrence.

Consider the 10 highest rankOorder items obtained for the combined groups. "Enjoyment of Science" was the highest ranking item and all 15 of the groups ranked this within the top ten. "Knowledge of the earth and its relation to the sun" (item #6), was rated second, and all groups with the exception of 06 ranked this one among the top ten. Item 35, "ease and confidence with materials and ideas in teaching science to pupils", was rated third most successful and 14 of the groups listed it among the top ten. The fourth highest ranking item was #17, "ability to plan simple experiences to teach science concepts to pupils, " ranked among the top ten for all groups but two. "Familiarity with available science materials, methods, procedures, and sources of information," item 7, ranked fifth highest -- all groups placed it among the top ten, with the exception of group 06 which ranked it in the bottom third. The next five items were items #25, 1, 4, 3 and 5 - "ability to increase the opportunities for pupils to collect data and make observations," "knowledge of the growth of animals and plants," "knowledge of motion and its relation to frames of reference," and "knowledge of temperature and thermometers," respectively. Four of the groups did not rank item #25 among the top ten, seven groups did not rank item #1 among the top ten, five did not rank item #3 within the first ten and nine groups did not rate item #5 as being among the ten most effectively reached goals.

It is interesting that again almost all the items dealing with change in actual scientific subject matter were among the most effectively realized.

The ten least successful items (based on total group scores) were items # 14, 31, 32, 15 and 33, 13, 30, 18, 2, 21, 26 and 24. These items were, respectively, "ability to examine trade books," "ability to conduct summarizations that raise new, but related questions," "ability to conduct summarizations that answer original questions," "ability to write explanations of science concepts" and "skill in evaluating the extent to which pupils have mastered a concept," "ability to scan science trade books," "skill in leading and conducting discussions of the findings," " skill in designing, constructing and/or

Table 34

Rank Order of Each of the 35 Statements of the Effectiveness R
Each of the Supervisory Groups (1 = highest rank, 35 = lo

Item	Total Group	01	02	03	04
1. Knowledge of growth of animals & plants	7	1	15.5	30	4
2. Knowledge of heat & effects on phases of matter	27	35	11.5	20	16.5
3. Knowledge of motion & relation to frames of reference	9	21	30	34	9.5
4. Knowledge of adaptive responses of plants & animals	8	2	11.5	30	12
5. Knowledge of temp. & thermometers	10	21	7	14.5	1.5
6. Knowledge of earth & relation to sun	2	5.5	7	6	4
7. Familiarity with available materials, methods..sources	5	8	4.5	3.5	8
8. Ability to distinguish..variety of teaching approaches	11	21	15.5	9.5	21
9. Ability to evaluate teaching experiences to demon-	18.5	16	4.5	20	16.5
strate a concept	13	12.5	7	14.5	16.5
10. Ability to select experience so pupils achieve concept	22.5	5.5	15.5	14.5	30
11. " to exploit materials for presenting to pupils	16	12.5	9.5	6	21
12. " to use home..experiences to develop concepts	30	17.5	32.5	14.5	30
13. " to scan trade books..for concepts	35	24.5	32.5	25.5	35
14. " to examine & abstract trade books	31.5	33.5	20	32.5	25
15. " to write explanations of concepts	22.5	12.5	27.5	20	34
16. " to coordinate textual & lab experiences	4	3.5	1	1.5	1.5
17. " to plan simple experiences to teach concepts	28	31	32.5	25.5	25
18. Skill in designing...materials	15	27	20	9.5	33
19. " in using models to explain	14	24.5	15.5	25.5	16.5
20. " " " instruments & materials	26	21	15.5	25.5	25
21. Ability to direct & focus on problem	18.5	8	23.5	6	12
22. " in making aim clear	17	31	20	3.5	25
23. " to plan & organize individual...observation	24.5	29	23.5	20	21
24. Skill in leading individual observation...	6	12.5	9.5	9.5	16.5
25. Ability to inc. pupils opportunity to collect data	24.5	17.5	27.5	25.5	9.5
26. Skill in raising pertinent questions	20.5	21	32.5	20	4
27. Ability to encourage pert. quest. from pupils	20.5	12.5	23.5	14.5	16.5
28. " to exploit pupils' findings...	12	12.5	27.5	14.5	12
29. " to...interpret simple data.	29	27	23.5	32.5	30
30. Skill in leading discussions about findings	33	33.5	27.5	25.5	25
31. Ability to conduct summarizations of original Q's	34	27	35	35	30
32. " " " " that raise new Q's	31.5	31	15.5	30	30
33. Skill in evaluating pupils' mastery	1	3.5	2	1.5	7
34. Enjoyment of science	3	8	3	9.5	6
35. Ease and confidence					

ble 34
nts of the Effectiveness Ratings for
(1 = highest rank, 35 = lowest rank.)

1	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
	1	15.5	30	4	8.5	4	25	21.5	13	34	6	6.5	4.5	5	14
	35	11.5	20	16.5	20.5	9.5	32.5	24.5	8.5	31	25	15	11	30.5	34.5
	21	30	34	9.5	8.5	8	22	5	8.5	9.5	2	4.5	11	15	4.5
	2	11.5	30	12	5	2.5	18.5	21.5	25.5	14	6	28	4.5	9.5	7
	21	7	14.5	1.5	25	2.5	30	24.5	5.5	14	9	19.5	11	23.5	14
	5.5	7	6	4	2	12.5	5.5	2	1	4	2	2.5	1	5	2
	8	4.5	3.5	8	5	21.5	3	5	18	4	6	1	11	1.5	6
	21	15.5	9.5	21	20.5	25.5	8	5	18	6	14	10	6	15	8
5	16	4.5	20	16.5	12	33	10.5	16.5	13	24	25	33	20	19.5	23.5
	12.5	7	14.5	16.5	20.5	29.5	10.5	10	22	24	9	24	11	19.5	17.5
5	5.5	15.5	14.5	30	25	29.5	22	16.5	25.5	31	19	24	11	33	14
	12.5	9.5	6	21	25	25.5	27.5	16.5	18	24	19	15	11	19.5	14
	17.5	32.5	14.5	30	25	16.5	32.5	33	34	18.5	25	34	11	35	23.5
	24.5	32.5	25.5	35	33	29.5	35	35	35	31	34	35	24.5	34	34.5
.5	33.5	20	32.5	25	33	6	32.5	28	33	9.5	35	31	24.5	30.5	33
.5	12.5	27.5	20	34	16	16.5	18.5	16.5	22	21	25	24	20	9.5	31.5
4	3.5	1	1.5	1.5	16	11	5.5	10	2.5	1	2	4.5	2.5	3	10
8	31	32.5	25.5	25	29	35	22	16.5	30	31	11	31	20	9.5	23.5
5	27	20	9.5	33	16	11.5	14.5	10	8.5	9.5	14	19.5	20	9.5	10
4	24.5	15.5	25.5	16.5	16	16.5	25	16.5	13	14	14	6.5	16	9.5	17.5
6	21	15.5	25.5	25	16	16.5	29	16.5	30	14	19	28	29	15	28.5
.5	8	23.5	6	12	33	21.5	5.5	28	18	7	30	15	29	27	23.5
7	31	20	3.5	25	8.5	16.5	14.5	24.5	8.5	28.5	25	19.5	24.5	9.5	10
.5	29	23.5	20	21	12	12.5	18.5	31	13	21	25	15	29	23.5	19.5
6	12.5	9.5	9.5	16.5	5	9.5	5.5	7	13	9.5	14	10	11	27	4.5
.5	17.5	27.5	25.5	9.5	20.5	25.5	14.5	10	30	18.5	25	24	24.5	27	23.5
.5	21	32.5	20	4	8.5	29.5	10.5	10	30	18.7	19	15	29	15	28.5
.5	12.5	23.5	14.5	16.5	12	33	18.5	24.5	22	24	14	10	20	23.5	19.5
2	12.5	27.5	14.5	12	25	6	10.5	16.5	5.5	24	19	10	29	15	14
9	27	23.5	32.5	30	29	21.5	14.5	31	25.5	34	30	19.5	32	19.5	28.5
3	33.5	27.5	25.5	25	29	21.5	25	34	25.5	14	32.5	28	34	30.5	28.5
4	27	35	35	30	33	25.5	32.5	28	30	28.5	30	24	34	30.5	31.5
.5	31	15.5	30	30	33	33	27.5	31	18	18.5	32.5	31	34	23.5	23.5
1	3.5	2	1.5	7	3	1	1	1	2.5	1.5	4	10	2.5	1.5	2
3	8	3	9.5	6	1	6	2	3	4	1.5	9	2.5	17	5	2

assembling simple materials," "knowledge of heat and its effects upon the phases of matter," "ability to direct and focus attention on the problem being considered" and "skill in leading individual and/or small group observations and discussions." These items seem to deal with fairly abstract classroom techniques for conducting lessons and with the participants growth as scientists (as opposed to elementary teachers of science.)

Item #14 was the lowest ranking item, all groups rated it as being among the 10 least effective; with one exception all groups placed item #32 in the bottom ten; all but two groups rated item #31 with the 10 least effective. Three groups did not feel item #15 was at the bottom, and two of these three rated this item among the ten most successfully met goals. One-third of the groups did not feel item #33 was included in the least effective. Five groups did not rate items #13 nor #30 as being particularly ineffective; one actually rated item #13 among the most effective. One of the four groups which did not rank item #18 as ineffective placed it among the 10 most effective items. On items #2 and #21, eight groups did not agree that these items were least effective. Six groups did not agree on the low ranking for item #26 (two groups ranked this item among the top ten) and 10 groups did not place item #24 at the bottom of the list.

It would seem that there is most agreement for those items at the extremes, especially the successful end, and that as one qpproaches the mid-point the number of groups agreeing lessens.

Part II. Modifications of the Institute:

Part II, the open-ended section of the questionnaire can be found in Appendix G. The first question in this part of the Teacher-Participants Evaluation of the Effectiveness of the Institute described an imagined situation in which the participants, "knowing what they know now," were to respond to the continuance, discontinuance of modification of the Institute. A count was made of the number of teacher-participants in each group who responded to the question concerning the (hypothetical) future of the Institute. Responses were obtained for all 220 persons.

Table 35 below presents the percentage of participants in each group checking future Continuance, Discontinuance, or Modification of the Institute.

82.a.

Table 35

Percentage of Participants, by Groups, who Wanted the Institute Continued, Discontinued, Modified

Groups

Percentage Checking:	N	Total %	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Continued	73	33.2	21.0	53.3	40.0	23.5	35.3	-	37.5	36.4	73.3	30.8	28.6	31.2	16.7	33.3	40.0
Discontinued	3	1.4	5.3	-	-	-	-	-	-	-	-	-	7.1	-	8.3	-	-
Modified	144	65.4	73.7	46.7	60.0	76.5	64.7	100.0	62.5	63.6	26.7	69.2	64.3	68.8	75.0	66.7	60.0
Total	220	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Almost all of the participants (about 99 per cent) were in favor of retaining the same general type of Institute for a future group of teachers similar to themselves: of the 217 "continued" and "modified" responses, one hundred forty-four of them indicated that the Institute should be modified; 74 persons checked "continued," but without exception all of these subsequently suggested some form of modification. Only three persons were of the opinion that the Institute should be discontinued. Although in general, almost two-thirds of the total participants indicated that the Institute was in need of modification , there were two groups in which more than half the participants wanted to continue the Institute, and one group where all participants were in favor of some form of modification.

A content analysis was made of the explanations and reasons for the selections of the three groups of participants; results of this analysis are available by supervisory groups but will not be presented here. Only combined groups scores follow. Each statement made was broken down into its different componants and a talley made of these responses.

Table 36 summarizes, by content category, the number and percentage of explanations given by the total of 73 participants who favored Continuation of the Institute. There was a total of 125 statements made, an average of 1.7 comments per respondent. (However, there were large differences between groups in the average number of comments per group; for example, the participants in group 13 averaged 4.0 statements while the participants in group 04 averaged a low of 0.75 comments.) As can be seen in Table 36, 90 or 72 per cent of the 125 comments are favorable and complimentary (noted in the table by an asterisk.) These comments concerned the effectiveness of the Institute in increasing participants' knowledge and understanding (approximately 23 per cent of the total comments), improving participants' attitudes, interest and confidence in science and science teaching (about 12 per cent), improving teaching skills and techniques (about 6 per cent). More than 10 per cent of the responses concerned the planning which was described as "well-planned," "almost perfect." On the other hand, almost five per cent of the total number of responses indicated that the participants felt that the Institute was in need of better organization and structure. The remainder of the comments all concerned specific modifications: better, more simplified and more sophisticated audio-visual materials (4 per cent), more depth and variety in materials and information (2.4 per cent), and a better library and more textbook assignments (2.4 per cent).

Some group differences, not included in Table 36, will be described: In general, the comments of groups 10, 02, 03 and 09 were almost invariably favorable; groups 01, 07 and 09 were divided, while group 13, for example, is most unfavorable suggesting the greatest percentage of modifications. Groups 04,05,11,12, 14 and 15 tend to be more favorable than not, suggesting modifications that account for roughly one-third of their total comments.

Table 36

Number and Percentage of Modifications Suggested by the 73 Participants Who Favored Continuation of the Institute

Items	N Comments	Per Cent Total Comments
1. Increased knowledge, understanding, philosophy of science	29*	23.2%
2. Improved skills, techniques	8*	6.4
3. Change grouping; group homogeneously by background	1	0.8
4. Improve quality of instructors	2	1.6
5. The materials were new and good	4*	3.2
6. The experts, outside speaker, lecturers (specified) were valuable	4*	3.2
7. Increased awareness of variety of resources	7*	5.60
8. Increased awareness of importance of pupil participation	2*	1.60
9. It was a stimulating experience	5*	4.0
10. Improved self-confidence, attitude and interest	15*	12.0
11. It was well-planned; good, almost perfect	13*	10.4
12. Needs more structure, tighter organization	6	4.8
13. Needs more relatedness to pupils, to the classroom	1	0.8
14. Needs better lectures and lecturers	4	3.2
15. Needs better field trips	2	1.6
16. The finances were excellent	1*	0.8
17. Needs more group interaction	1	0.8
18. Needs better tapes	5	4.0
19. Needs smaller size groups	1	0.8
20. Goals should be defined	1	0.8
21. Needs a better library, more textbooks	3	2.4
22. Needs improved methods of self-evaluation	1	0.8
23. Content was too difficult; simplify content	1	0.8
24. Needs more depth, more information	3	2.4
25. The working with children was good	1*	0.8
26. Instructors were excellent	1*	0.8
27. Eliminate individual projects	1	0.8
28. Improve the ways of working with children	1	0.8
Total (73 Continuation Respondents)	125	100.0%

Note: * Indicates favorable statements made by the participants

As can be seen in Table 36, 90 or 72 per cent of the 125 comments are favorable and complimentary (noted in the table by an asterisk.) These comments concerned the effectiveness of the Institute in increasing participants' knowledge and understanding (approximately 23 per cent of the total comments), improving participants' attitudes, interest and confidence in science and science teaching (about 12 per cent), improving teaching skills and techniques (about 6 per cent), and increasing participants' awareness of the variety and sources of materials (6 per cent). More than 10 per cent of the responses concerned the planning which was described as "well-planned," "almost perfect." On the other hand, almost five per cent of the total number of responses indicated that the participants felt that the Institute was in need of better organization and structure. The remainder of the comments all concerned specific modifications: better, more simplified and more relevant lectures (3.2 per cent), improved and more sophisticated audio-visual materials (4 per cent), more depth and variety in materials and information (2.4 per cent), and a better library and more textbook assignments (2.4 per cent).

Some group differences, not included in Table 36, will be described: In general, the comments of groups 10, 02, 03 and 09 were almost invariably favorable; groups 01, 07 and 08 were divided, while group 13, for example, is most unfavorable suggesting the greatest percentage of modifications. Groups 04, 05, 11, 12, 14 and 15 tend to be more favorable than not, suggesting modifications that account for roughly one-third of their total comments.

Only three persons voted having the Institute Discontinued. They averaged about three comments each, complaining of poor organization, inadequacy of materials and equipment, poor quality of supervisors and the overly large size of the groups.

As previously indicated, (see Table 35), two-thirds of the teacher-participants were in favor of future modifications of the Institute. This group of 144 persons made a total of 373 comments, an average of 2.59 - more responses per respondent than obtained for the Continuance group. There was a difference between groups in average number of responses, from 2.00 for group 03 to 3.78 responses for group 11. Table 37 summarizes the kinds, numbers and percentages of responses for the total group in favor of modification of the Institute. Breakdowns for each of the 15 supervisory groups are available but will not be presented.

For the total group favoring modification the most frequently mentioned need for change was in the kinescope tapes; about 10 per cent of their responses were concerned with improving the content or doing away with the tapes altogether. More than seven per cent of the responses indicated that the science information was too technical, and an additional seven per cent felt that the lectures could be simplified and the lecturers more carefully selected.

Another seven per cent of the comments were directed toward general modification of the organization, planning and structure of the Institute: more specifically, 3.5 per cent of the comments were concerned with the physical facilities, another 1.6 per cent with the need for a college setting (library, etc.), 3.5 per cent with the large size of the individual groups, 2.7 and 2.4 per cent with the selection of the participants and the supervisors respectively. Another 3.5 per cent indicated that the aims and goals of the program should be defined and adhered to. In general, for every content category the opposite was also included: For example, almost three per cent of the responses suggested less stress on theory and more on techniques and methods, while another three per cent of the comments were directed toward less methodology and more emphasis on theory. About two per cent of the responses favored an improvement in supervisory personnel while an almost equal percentage felt the supervisors were good and should be permitted more flexibility and freedom. However, it should be noted that the groups' patterns of responses differ. The groups may be characterized as follows: in group 01 the concern was primarily with administrative structure, organization and top-level personnel; group 02 was primarily concerned with the Institute's relevancy to the actual elementary level classroom (specifically noting that there should be more lesson planning and more appropriate and simple lectures); group 03 also suggested an increased emphasis on methodology and technique, indicating that the technical aspects were too difficult; group 04 indicated a need for stress on the schoolroom and the child; group 05 was concerned with the poor physical facilities of the plant and the inadequate viewing conditions of "kinnies" and lecturers. In addition, this group indicated inadequate supervision. On the other hand, group 06 indicated that their supervisor was excellent and there should be more theory and more individualized experiences. Groups 07, 08 and 09 were concerned with the large size of the groups, the kinerescopes and respectively, the experience with the children, the physical plant and the undue amount of theorizing; group 10 felt that the program, notably the lectures, were too technical; group 11 complained of wasted time and poor supervision; group 12 felt that the curriculum was too broad and the lectures - too technical to begin with -- were unrelated to the actual functioning of a classroom; group 13 was also concerned with structure and organization and was divided on the theory vs. methodology issue; group 14 felt that the material was too technical and should have more relevancy to the classroom; group 15 was similar to group 14 but in addition was very concerned with the quality of the kinescopes.

The next question in Part II asked the participants to list the specific areas, problems, and objectives that they received (1) most help in, and (2) least help in. The content analysis is summarized in Table 38. Results for the individual supervisory groups were analyzed, but only the combined total is presented in the table; group differences will, however, be described.

As can be seen in Table 38, about 61 per cent of the total number of 704 tallied responses were concerned with areas that participants received most help in. For each of the supervisory groups the number of most-help responses was greater than the least-help responses averaged 1.71 for group 11 to 0.60 for group 03. Clearly, in terms of quantity of responses, the groups were more verbal in describing the assets of the Institute.

Table 37

Number and Percentage of Modifications Suggested by the 144 Participants Who Favored Modification of the Institute

Item	N Comments	Per Cent Total Comments
1. Eliminate the working with children	5	1.34
2. Need more individual and individualized experience	13	3.48
3. Improve, and increase the laboratory sessions	9	2.41
4. Simplify lectures and improve quality of lecturers	27	7.24
5. Better selection of instructors	9	2.41
6. The directors were inadequate	7	1.88
7. Too much time was wasted	7	1.88
8. Physical facilities were poor, need improvement	13	3.48
9. Change environment, provide college setting and library	6	1.61
10. The information presented was too elementary, too little	11	2.95
11. Include seminars, discussions and follow-ups	5	1.34
12. Need more field trips	11	2.95
13. Provide some choice in activities	3	0.80
14. Improve organization and structure	26	6.97
15. Need less theory, more methods and techniques	10	2.69
16. Tapes were inadequate; improve or delete	39	10.46
17. Organize smaller groups	13	3.48
18. Spend more time on lesson planning	4	1.07
19. Assign more readings and homework	5	1.34
20. Need more audio-visual material	2	0.54
21. Need more emphasis on early childhood	4	1.07
22. Improve selection of participants	10	2.69
23. Have more materials and more easily available	8	2.14
24. Curriculum was too broad	3	0.80
25. Too technical	28	7.51
26. More relation to schools and children	22	5.90
27. Make groups homogeneous	1	0.27
28. Define aims, goals of Institute and roles of participants	13	3.48
29. Improve work with children	9	2.41
30. More emphasis on the disadvantaged	4	1.07
31. More theory needed, less methodology	10	2.69
32. Lectures were adequate	1*	0.27
33. Need more specialists, experts	4	1.07
34. Need more direction, supervision	1	0.27
35. Instructors need more freedom	8	2.14
36. Need more interaction between groups	4	1.07
37. Teachers should be involved in planning	1	0.27
38. Less time devoted to outside assignments	1	0.27
39. More emphasis on the physical sciences	1	0.27
40. Classroom methods were good	1*	0.27
41. Need more demonstration lessons	6	1.61
42. Materials should be graded	1	0.27
43. The materials and ideas presented were good	3*	0.80
44. Deemphasize the disadvantaged	1	0.27
45. The objectives were not carried out well	3	0.80
Total (144 Modification respondents)	373	100.0%

Note: * indicates favorable statements made by the participants

Forty-one per cent of the total (most-help plus least-help) responses were concerned with subject matter. The most frequently mentioned area was the physical sciences, followed by earth science and biological science. However, the physical sciences were most often described as being least helpful. (Seventy-two per cent of the physical science responses were of least-help type as compared with nine per cent of the earth science and 21 per cent of the biological science responses.)

For the total group of participants the areas mentioned most frequently included - in descending frequency - information, knowledge and understanding (61 per cent of these responses were "helpful"): the techniques and skills necessary for planning and conducting actual classroom lessons (85 per cent of the responses were "unhelpful"): the use of materials and equipment (more than 80 per cent were most helpful); resources and sources of available materials and information appropriate to New York City classrooms (half of the group said most-helpful and half said least-helpful); philosophy of science as related to individualized instruction and independent pupil discovery (82 per cent of these responses were of the most-help in type); a change in interest in, confidence with and attitude toward science (89 per cent received most-help in); understanding disadvantaged children (almost half and half); the role of the supervisors in providing guidance and follow-up (about 70 per cent of the responses indicated that supervisors provided very little help). Very few comments concerned other areas that the Institute was to be involved with; for example, organizing and interpreting data, evaluating pupils' performance and understanding, methods of self-evaluation, learning a variety of experiences and approaches, and the kinescopes.

As anticipated, there were wide differences between groups: group 01 indicated a great deal of help in the knowledge provided, especially in biological and earth science, and some little help in lesson planning and the physical sciences; group 02 also felt that earth science was helpful and physical science not helpful. In addition, group 02 was well satisfied with the materials and equipment and the techniques and methods for using them. Group 03 indicated that they received a good deal of help with materials and equipment that could be related to the classroom, and in general felt the Institute was extremely worth-while; group 04 appeared satisfied in general with the knowledges and understandings gained but not with the methods, techniques and skills necessary for implementation. Group 05 was impressed with the biological and earth sciences, but definitely not with the physical sciences. Group 06 indicated help in knowledge and information, especially as provided by their supervisor, but received little help in learning to prepare lessons which would lead to pupil discovery. Group 07, on the other hand, indicated much help with learning to lead pupil discovery and learning a variety of experiences applicable to the New York City classroom; group 08 received help in earth science but felt that they received little help from the supervisor. Group 09 indicated no help in physical science and much help in earth science. They felt that there was too little information provided and too little direction in indicated sources and resources for filling this gap. Group 10 received help in methods of presentation and knowledge, especially knowledge related to earth and biological sciences. Group 11 was primarily impressed with positively

Table 38

Number and Percentage of Comments Describing Those Areas of the Institute the Participants Found Most Helpful, Least Helpful

Item	N Most Help	N Least Help	N Total Comments	Per Cent of Total
1. Individual projects, papers, assignments	8	4	12	1.70
2. Using materials, equipment	29	7	36	5.11
3. Knowledge and understanding about science	36	23	59	8.38
4. Interest in, confidence with, attitude toward teaching science	24	3	27	3.84
5. Lesson and program planning	9	50	59	8.38
6. Ideas and materials for the classroom	16	1	17	2.41
7. Understanding Children, especially the disadvantaged	11	13	24	3.41
8. Improving own (self) resources	6	--	6	0.84
9. Lectures and lecturers	2	8	10	1.41
10. Field trips and observations	3	--	3	0.42
11. Kinnescopes and other audio-visual materials	1	3	4	0.57
12. Interpretation of data, findings	1	1	2	0.28
13. Sources of materials and information	14	14	28	3.98
14. Textbooks and readings	4	2	6	0.84
15. Defining science teachers' aims and goals	2	1	3	0.42
16. Learning a variety of experiences	5	--	5	0.71
17. Science and everyday phenomena	2	--	2	0.28
18. Exchanges between participants	2	--	2	0.28
19. Supervision and follow-up by supervisors	5	11	16	2.27
20. Laboratory experiences	8	2	10	1.41
21. Demonstration lessons	1	--	1	0.14
22. Methods, classroom presentations	20	6	26	3.69
23. Philosophy of pupil discovery	23	5	28	3.98
24. Self-evaluation	2	--	2	0.28
25. Mathematics and Science	1	--	1	0.14
26. No help at all provided	-	4	4	0.57
27. Everything provided was helpful	9	--	9	1.26
28. Biological Science	67	18	85	12.07
29. Earth Science	87	9	96	13.63
30. Physical Science	30	78	108	15.34
31. Organizing data and findings	--	1	1	0.14
32. Evaluating pupil understanding	--	2	2	0.28
33. Experiences (Institute) with children	--	6	6	0.84
34. Physical facilities	--	3	3	0.42
35. Trade Books	1	--	1	0.14
Sub-Total: biological, earth and physical science	184	105	284	41.04%
Total all items	429	275	704	100.00%

changed attitudes, interests and confidences but less with the aid received in the areas of lesson planning. Group 12 received some help in all informational areas, as revealed by the frequency of response, but as a group were divided on the other questions. Group 13 was the only group where the least-help category equaled in frequency the most-help category; they indicated help in individual activities, field trips and readings, and least help with increased understanding and ability to plan a lesson. Group 14 found biology and earth science helpful, but not physical science; they were least pleased with the areas of the disadvantaged and with all lectures. Group 15 found the Institute helpful in most areas with the exception of the physical sciences.

In summary, despite individual group differences the participants generally found the Summer Institute helpful and said so in both the quantity and quality of responses. As a group they indicated that they received most help in earth science, biological science, general knowledge and understanding, positively changed attitudes, methods, techniques, equipment and materials. They indicated, as a group, that they received less help in the physical sciences, with lesson planning, with sources of materials and with the disadvantaged.

The final question in part II of the *Teacher-Participant Evaluation of the Effectiveness of the Institute* asked the participants to suggest improvements for this type of Institute program. A total of 299 suggestions were made or an average of 2.27 suggestions per participant. Groups differed in average number of suggestions made; group 11 averaged 4.07 suggestions while group 13 averaged only 1.25 suggestions. The number and percentage of each type suggestion is summarized in Table 39 for the total group.

The two single most frequently mentioned suggestions concerned (1) improving the lectures and lecturers and (2) improving the kinnescopes. The participants suggested that the lectures should be simplified (about 8 per cent), the lecturers more carefully selected (about 4 per cent); they suggested that the lecturers should be more interesting speakers and the lectures should have greater applicability to the elementary school classroom. One per cent of the responses, on the other hand, indicated satisfaction with the lectures.

It is difficult to evaluate the comments about the kinnescopes because the intrinsic value of these films is not readily separable from the environment in which they were received. The filming technique was somewhat inadequate and the kinnies audio part was almost completely lost in the auditorium setting. At any rate, participants suggested either improving the films by using expert teachers, or doing away with them entirely, and perhaps, substituting "real-life" observations of classes.

A large proportion of the suggestions may be described as having to do with policy, organization and physical facilities. Almost six per cent of the responses were directed to improving the organization and structural administration of the Institute; another two per cent with time scheduling (time not used most productively.) Four and one-half per cent of the suggestions concerned more comfortable physical

Table 39

Number and Percentage of Suggestions for Improvements
Made by the Teacher-Participants (Total Group)

Suggestions	N Comments	Per Cent Total Comments
1. Improve organization, administration and structure	29	5.82
2. Do not waste time	11	2.21
3. Have more books, texts and a better library	11	2.21
4. Have real classes to work with; delete settlement house work	21	4.27
5. Improve physical facilities	22	4.42
6. Increase number of lectures - they were good	5	1.00
7. Improve tapes or substitute live observations	35	7.02
8. Improve quality of supervisors	21	4.21
9. Increase number of field trips - they were valuable	25	5.02
10. Construct materials or only provide those available to NYC	5	1.00
11. Gear to the disadvantaged	7	1.40
12. Need more adequate materials	6	1.20
13. The Planetarium was an excellent experience	4	0.80
14. Laboratory sessions need improvement or do away with	7	1.40
15. More follow-up, discussion and siminars needed	8	1.60
16. Need an Early Childhood staff	4	0.80
17. Individual projects should be deleted	4	0.80
18. Independent study was worthwhile	3	0.60
19. Improve and increase laboratory experiences	9	1.80
20. Improve the selection of participants	9	1.80
21. Give more responsibility to supervisors	14	2.81
22. Improve quality of lecturers	22	4.41
23. Increase the number of resource experts	18	3.61
24. Use testing program to diagnose weaknesses	9	1.80
25. Do away with the salesman and the commerciality	5	1.00
26. Have more interaction between groups	13	2.61
27. Establish goals, aims and objectives	6	1.20
28. Too easy, more factual information is needed	2	0.40
29. A good general background was provided	5	1.00
30. Some of the materials were good	9	1.80
31. The people were nice, contacts between them were good	2	0.40
32. Lectures were too difficult, simplify	38	7.62
33. Curriculum too broad, too much covered	4	0.80
34. Have smaller groups	13	2.61
35. Have fewer field trips	2	0.40
36. The techniques taught were good	4	0.80

Table 39 - cont'd.

37. The experience improved confidence	1	0.20
38. Need some exposure to alternate approaches	3	0.60
39. More emphasis on methodology, techniques, how to teach	8	1.60
40. Improve internal communication	2	0.40
41. Specific lecturer was good	3	0.60
42. Specific lecturers were poor	1	0.20
43. Biological science worthwhile	1	0.20
44. Less emphasis on methodology	1	0.20
45. More relation to classroom and age differences	13	2.61
46. Needs to be more formalized, participants need more discipline	6	1.20
47. It was inflexible, unprofessional	3	0.60
48. Experiences for participants should be individualized	9	1.80
49. The grouping was good	3	0.60
50. Directors and leadership was good	4	0.80
51. Improve motivation of participants	1	0.20
52. Improve field experiences	9	1.80
53. More emphasis on earth science	3	0.60
54. Reestablished own ideals about teaching	1	0.20
55. Everything was good	1	0.20
56. Everything was bad	6	1.20
57. Basic premise was good, implementation faulty	1	0.20
58. Biological sciences were inadequate	1	0.20
59. Laboratory sessions worthwhile	1	0.20
Total comments	499	100.0%

facilities (it was an especially hot summer) with special emphasis on having a library and a reference collection of books and materials available. Several conflicting suggestions were made about the structure, direction and communicative problems involved in a large Institute.

Almost two per cent of the comments were about the selection of participants with the suggestion that they be better selected to assure their interest and competency. Another two per cent wanted tests used to diagnose individual weaknesses, in order to group participants according to level of interest and background. Approximately three per cent suggested smaller groups and another 2.6 per cent wanted more interaction between groups. A very few responses indicated that the groups (size and quality) were adequate, the people nice and the personal contacts good.

There were several items about the supervisory and leadership aspects of the situation. About five per cent of the comments indicated that the expert leadership, noteably the directors, was good; three per cent felt that the supervisors were inadequate, and suggested that in the future more attention should be paid to the selection and training of supervisors. Two per cent of the total number of responses indicated non-professionalism, poor motivation and suggested more formalized discipline be required of the participants.

Suggestions about the content and the curriculum of the Institute were made: four per cent of the comments suggested the abolishment of the experiences with children; about five per cent indicated that the field trips were good and should be increased in number, while another two per cent indicated that the field trips were inadequate and should be eliminated in the future. It was suggested that the individual and independent projects be eliminated - be retained; the laboratory sessions were considered valuable (two per cent) - worthless (1.5 per cent). There was also conflicting suggestions about materials.

Slightly more than two per cent of the suggestions were for more emphasis on methodology and techniques on how to teach using a variety of approaches; another 2.6 per cent of the suggestions concerned relating the methodology and materials to the situation found in the New York City classroom. Some two per cent of the comments suggested less of an emphasis on methodology and techniques.

There was a variety of additional comments and suggestions (see Table 39), generally as many for increasing something as for abolishing the same thing altogether. Most of these apparent contradictions are accounted for by the differences between the supervisory groups. For example, most of the positive comments about supervisors were made by groups 06, 07 and 15, while groups 01, 04 and 11 account for most of the statements about supervisor inadequacy.

Again, as noted previously, different groups share different concerns: the suggestions made by groups 01 and 02 concerned the administrative and organizational aspects of the Institute; for group 03 the lectures were the source of concern; group 07 was concerned with group interaction and group 05, for example, was concerned with the methods and techniques for science teaching.

In summary, it is clear that in general the teacher-participants felt that the Institute had some positive effects, and had been effective in realizing most of its objectives. There were, of course, individual differences as well as group differences - in fact it is possible to characterize the groups on the basis of these differences.

It is our impression that the participants were quite verbal and outspoken in evaluating the Institute; in general they were intelligent and discriminating in their comments and suggestions which covered a wide variety of general and specific items. Foremost among the advantages was the increase in knowledge and understanding of the biological, physical and earth sciences. This is in accord with the results obtained on the tests of science information and also substantiates some general impressions. Participants also expressed an increased interest and confidence with science and science teaching; it is sincerely hoped that these effects will be transferred to the pupils in their classrooms.

RESULTS OF THE: SUPERVISOR-PARTICIPANT EVALUATION OF THE EFFECTIVENESS OF THE INSTITUTE

On the last day of the Institute, a rating scale was given to each of the 15 supervisors to complete and return as part of the total evaluation of the Institute. This scale, the Supervisor-Participant Evaluation of the Effectiveness of the Institute, is parrellel in form and intent to the Teacher-Participant Evaluation of the Effectiveness of the Institute. A copy of this instrument can be found in Appendix H.

Only seven supervisors, one teacher leader, three assistant principals and three anonymous supervisors, turned in ratings. These will be discussed but no attempt will be made to generalize the findings to the non-respondents.

The first section of this scale, which all seven supervisors completed, listed 35 goals and objectives of the Institute. Supervisors were asked to rate the effect of the Institute on each separate goal using a four-point scale where 1 = negative effect, 2 = no effect, 3 = some positive effect and 4 = outstanding positive effect. The mean rating of all supervisors on all 35 items was 3.18, slightly more than "some over-all positive effect."

The average rating for each item and the rank-order position of the items are summarized in Table 40. As can be seen, the range in rating is from a low of 2.71 (not quite same positive effect) to 3.71 (almost outstanding positive effect.) The lowest item ranking item was "teachers' ability to write explanations of science concepts." The highest ranking items were "teachers' enjoyment of science" and "teachers' ability to plan simple experiences to teach science concepts to pupils." Also highly rated was "teachers' knowledge of the growth of animals and plants", and "teachers' ease and confidence with materials and ideas in

Table 40

Average Score and Rank Order of the 35 Objectives as Rated by the Supervisor-Respondents (N = 7.)

Item: Teachers':	Mean Score	Rank Score
Ability to plan simple experiences to teach concepts to pupils	3.71	1.5
Enjoyment of science	3.71	1.5
Knowledge of the growth of animals & plants	3.57	4.0
Knowledge of the adaptive responses of plants and animals	3.57	4.0
Ease and confidence with materials and ideas in teaching science to pupils	3.57	4.0
Knowledge of temperature and thermometers	3.43	8.0
Ability to distinguish among a variety of teaching approaches	3.43	8.0
Skill in using models to study and explain science phenomena	3.43	8.0
Skill in using science instruments and materials	3.43	8.0
Ability to plan and organize individual and/or small group observation of a natural phenomenon	3.43	8.0
Knowledge of the earth and its relation to the sun	3.28	13.0
Ability to exploit extrant materials for presenting concepts	3.28	13.0
Ability to use home and community experiences to develop concepts	3.28	13.0
Ability in making the topic or aim of the lesson clear	3.28	13.0
Skill in leading and conducting discussions of the findings	3.28	13.0
Knowledge of motion and its relation to frames of reference	3.14	18.5
Familiarity with available science materials, methods, procedures and sources of info.	3.14	18.5
Ability to coordinate the use of textual and laboratory materials	3.14	18.5
Skill in designing, construction and/or assembling simple materials	3.14	18.5
Skill in leading individual and/or small group observations & discussions of a natural phenomenon	3.14	18.5
Ability to conduct summarizations that answer the original questions	3.14	18.5
Ability to evaluate teaching experiences to determine how well it will demonstrate a specific science concept	3.00	25.0
Ability to select the appropriate teaching experience through which pupils may achieve specific science concepts	3.00	25.0

Table 40 cont'd.

Ability to scan trade books for appropriate and pertinent concepts	3.00	25.0
Ability to direct and focus attention on the problem	3.00	25.0
Skill in raising pertinent questions about the findings	3.00	25.0
Ability to collect, organize and interpret simple data	3.00	25.0
Skill in evaluating the extent to which pupils have mastered a concept	3.00	25.0
Knowledge of heat and its effect upon the phases of matter	2.86	31.5
Ability to examine trade books for the purpose of abstracting the content	2.86	31.5
Ability to increase opportunities for pupils to collect data & make observations	2.86	31.5
Ability to encourage pertinent questions about findings	2.86	31.5
Ability to exploit and expand pupils findings, examples, and inquiries	2.86	31.5
Ability to conduct summarizations that raise new, but related questions	2.86	31.5
Ability to write explanations of science concepts	2.71	35.0

teaching science to pupils."

These ratings are very similar to the teachers' rating of the items. Teachers' rated as highly effective their enjoyment of science, their ease and confidence with materials and ideas, their ability to plan simple experiences to teach science concepts. There were some differences: for example, supervisors rated teachers' knowledge of "motion and its relation to frames of references" fairly low, while the teachers rated this item among the ten most effective. Teachers felt that there had been a highly effective change in their "ability to increase the opportunities for pupils to collect data and make observations," while supervisors rated the Institute as fairly ineffective in effecting this kind of behavior. The rank-order correlation between teachers and supervisors rating of the items was .61 - the agreement was mainly between the most successful items.

In the second section of the Supervisor-Participant Evaluation of the Effectiveness of the Institute, supervisors were asked about possible changes for future Institutes and about the strengths and weaknesses of this experience.

In general as a group, they did not say much. Four of the seven were in favor of the Institute being continued, all of them suggesting some form of modification. The remaining three respondents wanted modification of the Institute. The modifications included smaller total size and more structured and better planned interaction between groups.

The strengths of the Institute, those areas that the supervisors felt the teacher-participants received most help in were the laboratory experiences, planning for a more effective school program, lesson planning, the use of the experimental method, knowledges of specific subject areas, handling materials and the ability to distinguish between a variety of teaching approaches. The Institute was least helpful to the participants,according to the supervisors in teaching them some factual information, in helping them apply the theoretical knowledge to classroom situations, providing library facilities and materials available to the New York City classroom.

The supervisors felt that they, as supervisors, were most helpful to their participants in developing attitudes toward teaching science, in explaining and clarifying difficult concepts and translating them for use in the classroom, in encouraging teachers, and in analyzing the lessons. They were least helpful to their participants in helping them design science exhibits and in utilizing textual material. One supervisor noted that only those supervisors that had a good science background were able to effectively help their participants and fulfill their primary role of preparation follow-up and reinforcement.

The following suggestions were made: provide materials available to the NYC classroom and allow the participants time to experiment, manipulate and create activities for themselves and their pupils. Modify the lectures: the lectures were "too dry, too technical and too long" and there should be more time devoted to supervisors for clarifying the lectures. Participants should be made responsible for attending the sessions. Supervisors should have a complete set of materials in advance, and familiarity with the over-all objectives in order to transmit them to their teachers. Major strengths were the "esprit de corps" which developed, the administraters themselves and the materials they provided, the independent study projects, the development of positive attitudes and the overcoming of reluctance to handle live things, the insight into the "discovery" method, the discovery about pupil potential, and the realization by teachers that science is not a static subject.

Major weaknesses were: Not enough training for supervisors, supervisors should be an active part of the pre-planning; not enough time for supervisors to meet with their groups for discussion; insufficient amounts of materials; the lectures and the kinnescopes; the testing program and the physical facilities.

In making an over-all appraisal of the Institute one supervisor expressed the opinion shared by many supervisors and participants: Teachers learned many things, including the "intangibles", despite their own "willingness to express grievances about the program".

SUMMARY AND CONCLUSIONS

During a six-week period in the Summer of 1966, under a grant from the United States Office of Education, 221 teachers from 41 different schools in New York City and its environs completed an NDEA Institute workshop. These teachers, predominantly female, tended to be young and with relatively little prior teaching experience. Nearly all of the group had been education majors, having somewhat more than the semesters hours necessary for the baccalaureate degree. The teachers were divided into fifteen working groups having between 10 and 19 members and supervised by either an assistant-principal, district science coordinator or peer-leader.

The general objectives of the NDEA Institute were to increase the knowledge of the teacher-participants in selected basic concepts of the biological, earth and physical sciences; to provide them with available materials and techniques for teaching these concepts to children; to teach them techniques for exploring other science concepts and generalizations; to teach them to use curricular materials to teach processes and generalizations to their classes; to develop their teaching style for guiding inquiry in the classroom; and to help them master skills in the use of laboratory and educational materials and methods for teaching science.

A year-long evaluation of the effectiveness of the Institute was provided for; the planning of the evaluation began in March 1966, four months before the start of the workshop. We were interested in changes in the teacher-participants as a result of the Institute experience and decided on a pre- and post- Institute comparison design, where each participant would be compared with herself. It was hypothesized that group affiliation might be important, and wherever possible the findings were analyzed and presented by supervisory group.

The evaluation was directed toward five areas of interest: changes in knowledge and information; changes in attitudes toward science and science teaching; changes in teacher behavior in the classroom; changes in the schools and in the pupils; and over-all effectiveness and suggested modifications of the Institute. Nine measures were developed, fairly complete results were presented for seven of them.

The Teacher-Participant and *Supervisor-Participant School Checklist* was sent to all teachers and supervisors in April 1966 and March 1967. A sample of 39 teacher-participants were observed three times in their classroom - once prior to the Institute, once immediately after the Institute and the third time approximately one year after the initial observation - by trained observers using the specially developed *Observation Schedule;* although all participants were to be observed both pre- and post- Institute by the supervisor-teachers, this data was not complete enough for inclusion.

On the first and last days of the workshop the teacher-participants completed a battery of tests including the *Test of Science Concepts*, the *Elementary Science Survey* and a *Semantic Differential*. Added to the last-day test battery was an *Evaluation of the Effectiveness of the NDEA Institute* rating scale completed by both the teacher-participants and the supervisor-participants.

A summary of the major findings follows:

1. Changes in scientific knowledge and information - In general, the Institute was markedly successful in effecting positive changes in the amount and kind of scientific information and understanding available to the participants. Not only did participants learn more about the specific concepts covered by the curriculum, but there is some indication of increased learning in other content areas of the biological, physical and earth sciences. Their attitudes toward scientific knowledge also underwent changes.

At the start of the workshop participants felt that they were most knowledgable in biology; this was borne out in the pre-Institute testing. Gains in biology were not generally as large as the gains in earth and physical science, probably because of the initial high level of achievement in biology.

Participants expected to learn more earth, physical and biological science (in that order) as a result of the Institute experiences; the results indicated improvement in earth and biological science, and relatively smaller amounts of improvement in the physical sciences. The teacher-participants also felt that they received least (comparatively) help in the physical sciences, and rated the Institute as much less effective in this area as compared with the other science areas.

2. Changes in attitudes toward Science and Science Teaching - the

over-all findings indicate that the Institute had more than moderate success in effecting a positive change in participants' attitudes toward science and science teaching. In fact, the single most impressive result, noted again and again, was the change in feelings of ease and confidence and an increase in enjoyment with science and science teaching.

The participants themselves anticipated this outcome and rated their enjoyment of science as the most important result of the experience. They felt that the Institute was outstandingly successful in increasing their enjoyment of science teaching and improving their confidence. The supervisors concurred that the most important change in the participants was in this area of ease and confidence.

Specific attitudes also underwent favorable changes; the greatest shifts in attitude were in the personal-related concepts of Myself as a Science Teacher and My Teaching Skills and Techniques. Important positive changes in attitude occurred toward the concepts of Process-Centered Activities and Individualized Science Activities; these concepts are basic to the theoretical rationale of the Institute. The participants also said that they became more appreciative of the importance of pupil discovery and pupil participation.

On the other hand, the Institute was not particularily successful in certain other attitudinal areas, notably with participants' attitudes towards Difficult Students and Disadvantaged Children; nor did the Institute fulfill the participants' expectation that they would become "more effective teachers" as a result of the experience. Neither the participants nor the supervisors felt that the Institute was effective on the participants' ability to write explanations of simple scientific concepts nor on their ability to evaluate trade books. In addition the teachers felt that they did not receive enough help with the specifics of lesson planning, designing and constructing their own materials, nor with the sources of materials.

An unanticipated bonus was in the degree to which the curiosity of the participants toward science was aroused as a result of the experiences. In several different contexts mention was made of an increased interest in science and scientific phenomena.

3. Changes in teacher behavior in the classroom - The participants' expectation of becoming "more effective teachers" was not entirely realized. Not only did the participants themselves feel that the Institute was relatively unsuccessful in effecting this outcome, but the evidence from the classroom observations tend to support this conclusion.

In general the teaching behaviors did not show the same changes that would have been predicted on the basis of test results. The teaching behaviors most unrelated to science teaching, i.e., those behaviors characteristic of good teaching in general, changed least. For example, there was little improvement in the rating of participants' ability to direct, focus and clarify the aim of the lesson, little change in their ability to permit more pupil planning, collecting, organizing and interpreting the data.

However, the teacher-participants did exhibit more flexibility in the subject matter of the lesson taught, and more skill in ending the lesson. They also tended to use a greater variety of simple experiences and examples. There was a positive change in the degree to which pupils manipulated materials and in the kinds of pupil groups. In general the quality of the lesson improved and the teacher appeared more at ease after the Institute.

One of the more significant findings involved an increase in tolerance for what the participants described as "chaos" - increased pupil participation and individualized activities which result in more "noise and more physical movement" in the classroom. Also noted was a tendency to include more living things - plants and animals - in the lessons and in the classroom.,

The teachers feelings substantiate the observations. The participants felt better equipped to teach science and they were more comfortable with materials, instruments, observation and experimentation as well as with small group instruction. They indicated however, little change in their ability to design their own materials, to direct and focus attention on the problem being considered, to lead discussions of the findings and to conduct summarizations that answer the [illegible] question and raise new, related questions.

4. Changes in the schools and in the pupils - Little direct data on changes in the school and in the pupils was available. In general, there seemed to be few changes in the schools represented by the participants and whatever structural and organizational changes did appear cannot necessarily be attributed to the NDEA workshop.

Several participants were given science cluster or OTP responsibilities in their schools as a result of their special training; others acquired additional science responsibilities. Primarily because of change in assignments and scheduling there was little evidence that more science was being taught in the schools after the Institute. Although many participants expressed the inadequacy of the existing science curriculum and materials, others indicated that as a result of the Institute they were better able to realize the potentials of the available materials and equipment.

There were some interesting findings with regard to changes in pupils. Participants and observers tended to rate level of pupil interest in science higher after the Institute than before; in addition, a greater proportion of pupils were seen as highly interested.

Participants also found that pupil ability was greater than they had believed prior to the Institute and the participants judged themselves as significantly better than average in their own ability to evaluate how well pupils have mastered a concept. Perhaps more importantly was the realization by some participants that teacher attitude directly affects pupil attitude.

5. Overview - The variety of individual responses and the variety of group responses, although evident throughout the results, are especially apparent in the findings dealing with modifications and suggestions for the Institute. For every "pro" there was a "con", for every "best", a "worst", but over-all it is obvious that the 1966 NDEA Institute in Science was a success; in general, most came to enjoy science; most felt more confident and at ease in teaching science; most felt well-equipped to teach science and most of the participants felt that the Institute was successful in imparting scientific information and in teaching participants individualized techniques and in improving their own attitudes and increasing their own interest.

A large proportion of the suggestions concerned the selection of participants and supervisors. The teachers felt that more attention should be paid to the needs of disadvantaged children, to lesson planning and to materials and equipment that would be available to teachers in the New York City classroom. They suggested improving the quality of the lectures and lecturers and the Kinnescopes - perhaps substituting work with children. There was much emphasis on the physical surroundings as well.

Different individuals and different groups made various suggestions based on their own backgrounds and on the specific experiences they had during the summer. All but a very few individuals felt that they got something of worth from the Institute.

LIMITATIONS OF THE INSTITUTE, THE EVALUATION, AND SUGGESTED MODIFICATIONS AND IMPROVEMENTS

1. Selection of the Participants - There is some question about the selection of the participants. The 221 participants in this Institute represent a rather heterogeneous group, in age, experience, school assignment, grade level assignment and in the interests, motivations, preparations and backgrounds they bring with them. Several of the participants themselves noted uneven degrees of interest in the Institute and expressed concern with the motivations of their colleagues. While it is important to restrict the acceptance of participants to the criteria laid down, some modification in grouping participants (see below) may provide a more adequate solution to the problem of heterogeneity.

2. Selection of the Supervisors - In a large size Institute of this sort, where most of the learning is to occur within groups, the selection and role of the supervisors play a key part. In this Institute, supervisors were either Assistant-Principals, District Science Coordinators or Peer-Leaders. Although complete statistical comparisons and intercorrelations by groups were not available, there is much evidence to suggest that the supervisor may make a difference. However, it is impossible to state conclusively, for several reasons, which if any of the types of supervisors represented, is the "best" type. Firstly, the groups differ in size from 10 to 19 per group.

Secondly, the groups are randomly composed of teachers from one to four different schools. And thirdly, the groups differ in amount and kinds of homogeneity. Depending on which results you look at different factors, including who the supervisor is, become important. There is some indication, for example, that if you are primarily interested in increasing amount of scientific knowledge, district coordinators may represent the "best choice." Peer-leaders and Assistant-Principals may represent a good choice if you are interested in school-wide changes.

The formal title of the group supervisor may be of lesser importance than some more personal characteristics of, for example, how well does the supervisor know the participants, what role did he have in their selection, is he a "fighter" for the "rights" of his group, etc.

3. Size of Total Group and Groups - There were many indications that, as organized for this Institute, the size of the total group and the size and interactions of the individual groups present some hazards. Obviously a group of more than 200 persons cannot physically fit in ordinary, every-day surroundings and cannot have equal materials. Some groups are bound to get to the auditorium or library first and avail themselves of the better seats, books, etc. Some supervisors may be better than others at this also. If the size of the total group is not limited, much more careful grouping is indicated, with a view to eliminating within-group heterogeneity.

As noted, although some participants felt this was a good opportunity to "meet a lot of nice people," this was not the primary purpose of the Institute. Perhaps groups should be established on the basis of diagnostic tests of prior preparation and background, on the basis of grade level taught, or on some other basis which would facilitate small-group instruction. At any rate, all groups should be provided with essentially comparable materials; schedules of use of other facilities can be arranged - there seems to be no reason for the total group to view together the Kinnescopes, for example, although of course, some of the outside lectures may be more difficult to schedule.

4. Physical facilities - Unfortunately the physical facilities of the Institute play an important part, especially to the participants. The inaccessible elementary school building, the small rooms, the "un-air-conditioned" environment and the library and auditorium ranked high on the list of complaints. It is suggested that, if possible, the surroundings should be made as comfortable as possible, primarily in order to minimize their importance. It would also appear to be important to try to arrange that the workshop be held on a college campus for several reasons: to provide the participants with a real sense of obtaining college credit for their work which in turn may maintain their interest and improve their motivation; the college campus usually has large enough rooms, lecture halls and laboratories as well as eating, parking and other facilities.

5. Expectations - As noted in the results there is often extreme variance between the expectations of the participants, and the goals - implicit and explicit - of the Institute. The variance between these

sets of expectations often leads to dissatisfactions, and sometimes to feelings of "betrayal." If all objectives of the Institue and some of the underlying theoretical foundations were made explicit we feel it would not only negate some of the general dissatisfaction but would eliminate those few participants who may have applied "for the wrong reason."

6. "Action-Research" - There are, of course, limitations in any action-research program. Three of these limitations will be discussed in detail, (1) the assignment of teachers, (2) the problem of non-respondents and, (3) the total-impact nature of the evaluation.

One of the conditions for acceptance as a participant was an indication on the part of the applicant that she planned to remain in the same school (same as during the school year prior to the Institute) during the year after the Summer workshop. As described in the section on the "Results of the Teacher-Participant Checklist", there were a great many changes in teaching assignment - from school-to-school, between grades, on the same grade but different level, and from a self-contained classroom to a cluster or OTP assignment. As a matter of fact very few teachers actually remained with the same level, same grade class. Not only did this mobility make individual before and after comparisons difficult, it also may have tended to dilute the school-wide impact of the Institute program. This reassignment of personnel (including the supervisor-participants), confounded all results from the rather simple measures dealing with the adequacy of materials to the costly and time-consuming classroom observations. The evaluators found it extremely difficult to compare one teacher of a bright first-grade class with her own performance one year later as a cluster teacher doing a "demonstration" lesson with a middle-level third grade class.

While it is not our intention to impose conditions on the school system it can be suggested that perhaps some provision be made for all teachers involved in a research project to receive special consideration as regards assignment. The alternative may be to base comparisons only on those persons with the same assignment for the years covered by the project. However, since we do not know exactly what any one or any class of reassignment represents, treating the data in this fashion may seriously bias the results.

Closely related to the reassignment of personnel is, in this instance, the problem of non-respondents. In this study there are two types of non-respondent: those who did not return a form and those who only partially completed a form or test. We are more concerned with those persons who did not complete and return an entire form.

In general the per cent return on any one item tended to be fairly high, especially for the pre-Institute administrations. After the Institute there were significantly fewer responses to the Checklist in particular, and a few end-Institute instances where the participants did not return the Test of Science Concepts, the Elementary Science Survey, the Semantic Differential and the Effectiveness Ratings. In addition, one of the sample teachers observed in the classroom refused to be observed after the Institute and one or two others were absent on that day. It is very tempting to hypothesize that the non-respondents are a group of dissatisfied participants expressing their dissatisfaction in this way. However, we can not easily accept this hypothesis; there is some data which suggests that dissatisfied participants are interested in actively expressing their complaints - there were several quite vehement "gripes" noted. Perhaps the non-respondents represent a more apathetic group or perhaps may be the group that has moved away (as is suggested in the responses to the Checklist.)

A third problem common to any action-research program is the "total impact" nature of the program and of the evaluation. With this type of design it is nearly impossible to attribute the outcomes to any specific variable - activity, schedule, personnel, etc. It is entirely possible, although not at all likely, that the positive outcomes in science information for example, may be attributable to the number of times the participants read the brochure rather than to either the lectures, laboratories or assigned readings. In fact, in a more rigid experimental design it should be possible to determine which variable actually produced each specific outcome. This would save great amounts of time and money; if we could determine which variable or combination of variables produced which results we would have to replicate only the significant features in a similar situation to produce similar results. Although this type of design requires greater control than is usually available in education - research projects, some attempt should be made to parallel this design as closely as possible.

7. The Tests and the Testing - It is important that the battery of tests be administered under better physical conditions than prevailed in this study. In addition, perhaps the initial battery, especially those tests purporting to measure the amount and kind of information in the participants' background, could be administered before the start of the Institute and be used diagnostically for the purpose of homogeneous grouping.

With a few exceptions described below we were generally satisfied with the instruments used in this study. However, more time was needed for the development of alternate forms of the Test of Science Concepts and the Elementary Science Survey. Without the use of alternate forms or some "control" data on practice effects, is is impossible to attribute all of the significant gains obtained to learning, rather than to the test-retest situation. As an alternative to comparable forms, some data on practice effects should be collected on a control group of teachers; the same time interval between administrations should be used. It is suggested that this might be the better procedure with the Elementary Science Survey, but alternate and comparable forms of the Test of Science Concepts should be developed.

More time for planning and try-outs may have reduced the amount of inter-rated disagreement on the items comprising the Classroom Behavior Schedule. As noted in that section of the results, there was much disagreement on several items; although some attempt was made to eliminate personal bias, we feel it was largely ineffective. The additional needed time could be used either to train the observers and/or to simplify the items; it is hoped that either suggestion would result in better inter-rated agreement and more reliable results. The data also indicates that due to teacher mobility, sickness, etc. more participants should be observed initially.

Several questions in the Checklist were ambivalent; participants did not seem to understand exactly what was required. It is suggested that in the future, questions concerning amount of time spent, effective-ineffective teaching aids, equipment, field-trips, etc. either be eliminated from the form, or simplified. More attention should be paid to the participants' responsibilities for science and to their attitudes concerning the kinds and levels of interest and potential exhibited by the pupils in their class.

We feel that the Effectiveness Rating Scale was a very useful and informative instrument. It is the only instrument in the battery that directs the participants to the objectives of the Institute. In addition, it provided the participants with an opportunity to express themselves and in their own words. These open-ended items permitted the flavor and characteristics of individuals to emerge and presented us with a wealth of suggestions that we would not have obtained had we used only structured forms.

One final word about the tests used in the evaluation. While we are all of the opinion that the Semantic Differential was one of the most invaluable measures used, the time needed to score and process the data may discourage its use in the future. Although it is fairly simple to develop a machine-scored answer sheet of the optical-scan type, some care must be taken to assure comparability of results with this type of form and the format suggested by Osgood.

8. Treatment of the Data - It is obvious that there were gaps in the statistical treatment of the data. First and foremost is the absence of intercorrelations between variables. Secondly, the generalized distance formula used by Osgood was not used to analyze the results of the Semantic Differential. And lastly, most of the data was treated fairly simply.

We are of the opinion that due to the confounding of variables and the things over which we had little or no control,more sophisticated statistical analyses would be presumptuous. We would like to have had the time to present intercorrelations between factors we hypothesize as related, however, and would have liked also to include all data by groups. The data is available for all comparisons and may be reanalyzed in the future.

9. Aspects of the Institute not covered by the Evaluation - Not much of an attempt was made to evaluate certain aspects of the Institute that might or might not be important. For example, although we asked the supervisor-participants to complete an Effectiveness rating, there was no follow-up attempt to secure the missing forms. In addition, we have little concrete information about the level of interest in and amount of knowledge of science that the supervisors have; more importantly, we have only a smathering indication of their effectiveness with their own groups.

All of our interest was focused on the teacher - and not as a tool in the learning process, but rather as an end in itself. It is an untested assumption that a change in teacher attitude and knowledge will result in a change in pupil achievement. Aside from a few classroom observations, primarily directed toward noting changes in teaching behavior, this evaluation did not seek to measure the effectiveness of the teacher in raising the achievement of pupils. It is our opinion that ultimately the success of any educational program must be judged in terms of a positive change in pupil success in school. No amount of classroom observation of teaching behavior will yield information about how much children are learning.

It is possible that without knowing much science a "good" teacher may be able to lead pupils to discover for themselves, may instill in the pupils the curiosity and attitudes without which a true understanding of science and scientific processes are not possible. It is again possible that a teacher who makes mistakes, who is awkward with instruments and equipment may foster the necessary point-of-view for the appreciation of science. This is not to suggest that we should not try to make our teachers more knowledgable and more adept, nor does it necessarily mean that we should not try to measure how successful we were in trying to do this; but rather, we should recognize this as a preliminary step in the ultimate objective of improving the learning of pupils in the classroom. The criterion against which to measure program success must be pupil achievement.

APPENDICES

Appendix A: Statement of Objectives for Teacher-Participants

Appendix B: Teacher-Participant School Checklist

Appendix C: Supervisor-Participant School Checklist

Appendix D: Test of Science Concepts

Appendix E: Elementary Science Survey

Appendix F: Semantic Differential

Appendix G: Teacher-Participant Evaluation of the Effectiveness of the Institute

Appendix H: Supervisor-Participant Evaluation of the Effectiveness of the Institute

Appendix I: Supervisor Observation Schedule

Appendix J: Evaluators' Classroom Observation Schedule

NDEA INSTITUTE IN ELEMENTARY SCHOOL SCIENCE

STATEMENT OF OBJECTIVES FOR TEACHER-PARTICIPANTS

I. Process Oriented Teaching Behaviors

Each participant should demonstrate teaching styles appropriate for guiding inquiry in his classroom:

A. Directing and focusing attention on the problem being considered;

B. Organizing and leading individualized and/or small group observation of a natural phenomenon;

C. Conducting discussions of the findings of individuals and/or small groups with regard to a natural phenomenon;

D. Raising pertinent questions about findings and encouraging such questions from individuals and/or groups;

E. Leading summarizations so that while original questions are answered, new and related questions are raised;

F. Exploiting the findings of individuals to extend and expand the inquiries being conducted.

II. Techniques

Each participant should be able to:

A. Examine science trade books and abstract their content; scan books for their appropriate and pertinent concepts; write brief explanations of pertinent concepts.

B. Select appropriate experiences through which children may achieve concepts; test perceptual experiences to determine how well they demonstrate a concept.

C. Exploit extant materials for presenting concepts to children.

D. Evaluate the extent to which a group of children and/or an individual child has mastered a concept.

E. Select from home and community environment experiences which can be utilized in the development of science concepts.

III. Skills

Each participant should demonstrate a mastery of:

A. Use of simple materials for teaching science concepts and processes to children; coordinate use of textual and laboratory materials.

B. Planning simple experiences with which to teach science concepts and/or processes to children; designing simple materials with which to teach science concepts and/or processes to children.

III. Skills (continued)

C. Using simple scientific instruments: thermometers, glass or plastic ware, simple chemicals: gathering, organizing, and interpreting simple data; planning and executing simple experimental procedures; using models to study and explain natural phenomena.

IV. Knowledges

Each participant should demonstrate knowledge of the following concepts:

A. Temperature can be measured;
A thermometer is one instrument for measuring temperatures;
The level of the indicator in a liquid thermometer changes as the temperature varies;
Matter can exist in solid, liquid, or gaseous state;
When matter changes from one phase to another, an exchange of heat is generally involved;
Heat is energy in transit due to temperature difference. It moves from a source (hotter matter) to a sink (colder matter).
Matter generally expands when heated; matter generally contracts when cooled.

B. Motion occurs when a body changes its place or position relative to a chosen frame of reference;
Direction of motion is described with respect to a chosen frame of reference;
A body can undergo simultaneously a combination of motions (translation, rotation, vibration);
The earth is round (spherical);
The earth rotates;
Day and night are results of the rotation of the earth;
The earth is in constant motion relative to the sun; the earth revolves and rotates simultaneously;
Certain physical conditions result from this motion: day and night, seasons.

C. Many animal offspring resemble their parents, but they are smaller;
Animals, including humans, grow; the parts of their bodies grow;
New plants can grow from seeds, from bulbs, or from tubers;
The principal parts of plants vary in appearance from one species to another;
Plant growth takes place at specific places in the plant;
Animals respond to stimulae in their environments: light, moisture;
Plants respond to stimulae in their environments: light, gravitation, moisture.

It should be noted that each of the sub-divisions of any of the three large headings can be sub-divided into further, valid, but less general, concepts. Such sub-concepts, sub-skills, or sub-techniques very well may be of use in evaluating either the teacher-participants individually or the program generally.

NDEA INSTITUTE IN ELEMENTARY SCIENCE

SUPERVISOR-PARTICIPANT SCHOOL CHECKLIST

School (boro): Date:
Supervisor-Participant Name:

1. During 1965-66 what was your official position in, or relation with, this school?

2. Do you expect any change in position or assignment in, or with relation to this school next year (1966-67)? Yes:____ No:____ If yes, please describe briefly.

3. In grades K-4, is there a weekly time allotment for science instruction? Please indicate for each grade the amount of time per week scheduled for science.

K:\________________
Grade 1:__________
Grade 2:__________
Grade 3:__________
Grade 4:__________
At teacher's discretion (specify grade):____

4. Is there a special science program in this school? Yes:____ No:____
If yes, please describe briefly (include grades involved, number of teachers, etc.):

5. Is there a special science room in this school? Yes:____ NO:____ Is the room used for all science lessons, all grades, special demonstrations, etc.? Please describe briefly:

Who is responsible for maintaining this room?

6. Is there a school library? Yes:____ No:____
Is there a collection of science books? Yes:____ No:____ Approximately what percentage of the total collection is science (i.e., 500 and 600 books in the Dewey system)?

Is there a state-certified librarian? Yes:____ No:____ If not, who has general over-all responsibility for the library?

By whom are science books selected? (By committee, individual teacher recommendation, Board of Education, Principal, etc. Please describe specifically):

What criteria are used in evaluating science books?

Who evaluates the science books?

How are teachers informed of new library acquisitions related to science?

What science books were ordered for the coming year, 1966-67? Please list (use back of page if necessary):

7. Are science materials, supplies and equipment stored centrally?
Yes:____ No:____ Please describe briefly:

How are materials borrowed from the central supply?

Are there enough supplies, materials and equipment for individual pupil experiences?
Yes:____ No:____ Please specify:

What new supplies, materials and science equipment were ordered for the coming year, 1966-67? Please list (use back of page if necessary):

8. Is there a specific person assigned responsibility for science supplies, materials and equipment? Yes:____ No:____ Please indicate the title of the person(s) who is responsible:______________________________

Is this person(s) responsible for:
  Suggesting and requisitioning materials: Yes:____ No:____
  Maintaining and repairing materials and equipment: Yes:____ No:____
  Evaluating materials and equipment: Yes:____ No:____

How are priorities for purchase determined? Please describe briefly:

How are teachers informed of new science acquisitions?

9. Please indicate, by circling the appropriate number on the scale, the general level of interest with and involvement in science in this school:

1	2	3	4	5
	Somewhat less than average	Average interest	More than average interest	Science-oriented

On what factor or factors do you base this general impression? Is there an annual science fair in the school, are there science exhibitions and displays, is there a science competition, etc.? Please try to be specific in describing your impression of the interest level in science in this school.

Additional Comments:

NDEA INSTITUTE IN PRIMARY GRADE SCIENCE
Hunter College

TEST OF SCIENCE CONCEPTS

INSTRUCTIONS

This test consists of six reading passages on different science subjects and seven multiple choice questions for each passage. You should read each passage carefully and then answer the seven questions on that passage. After you have finished one passage go right on to the next one. There is no time limit on this test, but try to work rapidly.

Answer all questions on the separate DIGITEK answer sheet by blackening the space corresponding to your choice of the best answer to each question or the best completion to each incomplete statement. Please DO NOT WRITE IN THIS BOOKLET. If you wish to use scrap paper, you may. Be sure that your name is clearly PRINTED in the proper spaces on the answer sheet.

(Questions 1 - 7)

Suppose you are looking at the street and you see a car to your right. If you close your eyes and then look again two seconds later and the car is now on your left, what do you assume? You probably assume that during the two seconds when your eyes were closed the car moved from your right to your left. But, since we are supposing, suppose it is the year 2,000 A.D. and the "sidewalk" you are standing on is really a very smoothly moving belt. If while your eyes were shut, it moved you toward your right, the result would be the same; the car would appear on your left after you opened your eyes. There is one more possibility: both you and the car moved while your eyes were closed.

Could you decide what had happened? You could not, if you and the car were the only things on the street. All you could say is that you and the car were in different positions with respect to each other before you closed and after you opened your eyes. A more precise way of saying this is that your relative positions were changed. From your point of view, or, more precisely, from a frame of reference attached to you, it may be said that the car moved relative to you. From the driver's point of view, or from a frame of reference attached to the car, it may be said that you moved relative to the car. (Think what the driver sees: first he sees you out of the front window, then he sees you in the rear view mirror.)

If there were a third thing on the street, for example a tree, then you might be able to be more definite about who moved. If you and the tree were in the same relative positions before you shut your eyes and after you opened them, then you would probably say that the car moved. This is what we do all the time. We pick a reference point or points (like a tree) and if something (like a car) changes its position relative to that reference point (or frame of reference), then we say it (the car) has moved. In precise terms: the car has moved relative to the frame of reference. Since we took as our reference point something which was firmly rooted to the earth and which we assume does not move relative to the earth, we can say that the car moved relative to the earth. (Remember, our whole problem arose when we were not sure if we had moved relative to the earth.)

When we speak of motion which takes place on the earth, normally we assume that the earth is our frame of reference and things are moving relative to the earth. However, anything which is convenient may be used as a frame of reference. For example, it is more convenient mathematically to use the sun as a frame of reference when discussing the motions of planets in our solar system.

Suppose you are sitting on a train which is moving (relative to the earth) due west at a constant speed of 35 miles per hour. You stand up and start walking toward the rear of the train at a constant speed of 4 miles per hour (relative to the train).

1. How fast and in what direction are you moving in relation to the earth?

   (1) 35 mph west (2) 39 mph west (3) 31 mph west (4) 4 mph east
   (5) 4 mph west

2. As you walk, how fast are you approaching and passing seated passengers?

   (1) 4 mph (2) 31 mph (3) 39 mph (4) 35 mph (5) 8 mph

3. If while you were walking toward the rear of the train, just as you entered the front of a car, someone else entered the back of the car and he was walking towards the front at 5 mph (relative to the train), What would be your speed and direction relative to him?

   (1) 4 mph toward him (2) 44 mph toward him (3) 9 mph toward him
   (4) 40 mph toward him (5) 5 mph toward him

4. In the same situation as number 3, what is the other person's speed and direction relative to you?

   (1) 5 mph toward you (2) 39 mph toward you (3) 9 mph toward you
   (4) 4 mph toward you (5) 44 mph toward you

5. Suppose a car is driving at 40 mph west (relative to the earth) on a road paralleling the train track. How fast and in what direction is the car travelling relative to the train?

   (1) 40 mph west (2) 75 mph west (3) 35 mph west (4) 5 mph west
   (5) 5 mph east

6. How fast and in what direction is the car in number 5 travelling relative to you as you walk toward the rear of the train?

   (1) 40 mph west (2) 71 mph west (3) 39 mph west (4) 9 mph west
   (5) 1 mph east

7. As you are walking toward the rear of your train, a freight train passes you travelling east at 40 mph (relative to the earth). A man is walking along the top of the box cars toward the rear of the freight train at 5 mph (relative to the freight train). How fast and in what direction is the man moving relative to you?

   (1) 35 mph east (2) 40 mph east (3) 75 mph east (4) 66 mph east
   (5) 84 mph east

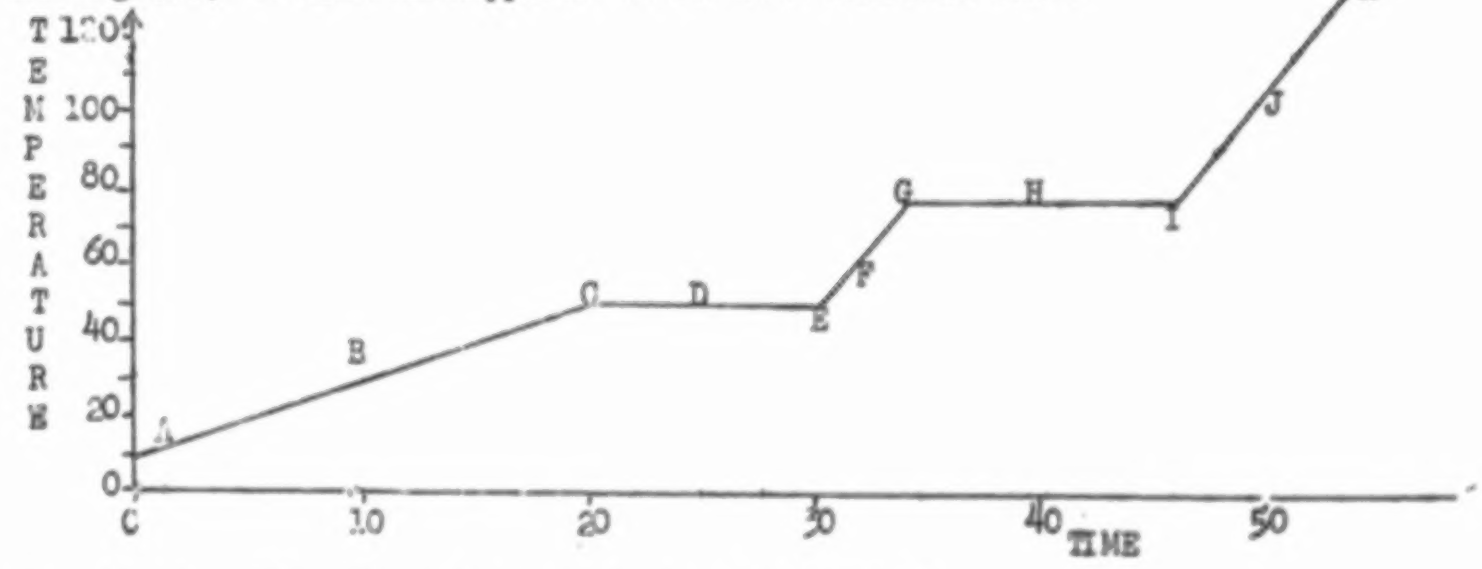
(Questions 8 - 14)

In general, as heat is applied to a substance at a constant rate, its temperature increases at a constant rate (which depends on the physical state or phase of the material), until either the melting temperature or the boiling temperature is reached. At either of these temperatures, the application of heat does not produce a temperature change until all of the substance has changed phase.

Some types of materials, called elements and compounds, react in unique ways when heated at a constant rate. When a solid piece of one of these materials is heated in this way, its temperature increases at a constant rate until it starts to melt - that is, until it reaches what is called its "melting temperature." At its melting temperature, even though heat continues to be applied to the material at the previous, constant rate, the temperature of the material remains the same until all of the solid has been melted.

Only after the solid has completely melted will heat again affect the temperature of the material. However, when all the material has turned to liquid, as heat continues to be applied at the original rate, the temperature of the liquid once again rises at a constant rate. But one thing must be noted. Even though the heat is applied at the same rate for both the solid and then the liquid, the rate of temperature increase for the liquid form of the material is not necessarily the same as its rate of temperature increase in solid form. With the continued steady application of heat, the temperature of the liquid material continues to rise at this constant rate until the liquid starts to vaporize - that is, until it reaches what is called its "boiling temperature." At its boiling temperature, even though the material continues to be heated at the previous, constant rate, the temperature of the material does not change until all of it has boiled or vaporized. Once all the material has changed from a liquid to a gas or vapor, then with the constant application of heat, the vapor's temperature once more rises at a constant rate. But, once again, the rate of temperature rise for the vapor is not necessarily the same as the rate of rise in temperature of the liquid, nor is its rate of temperature increase necessarily the same as it was when the material was in its solid state.

The graph below shows the temperature of a substance (starting as a solid at 10 degrees) as heat was applied to it at a constant rate.



8. At time "B", the substance is in what phase?

(1) solid (2) liquid (3) vapor (4) part solid, part liquid (melting)
(5) not enough data to tell

9. At time "F", the substance was in what phase?

(1) solid (2) liquid (3) vapor (4) part solid, part liquid (melting)
(5) not enough data to tell

10. During what time period is the substance vaporizing (changing from liquid to vapor?)

(1) "A" to "C" (2) "C" to "E" (3) "E" to "G" (4) "G" to "I" (5) "I" to "K"

11. The melting temperature of this substance is

(1) 10° C (2) 30° C (3) 50° C (4) 60° C (5) 76° C

12. Under these conditions, this substance is a liquid between what two temperatures?

(1) 10 - 50° C (2) 30 - 50° C (3) 50 - 76° C (4) 76 - 100° C
(5) 10 - 100° C

13. Under these conditions, this substance is a vapor above what temperature?

(1) 10° C (2) 50° C (3) 60° C (4) 76° C (5) 100° C

14. If the rate of application of heat were changed, the graph would look

(1) the same because rate of application of heat does not determine the slope
(2) the same because rate of application of heat does not affect the melting and vaporizing temperature
(3) somewhat different because the melting temperature and vaporizing temperature will be the same, only the slopes of the lines will change
(4) somewhat different because the melting and vaporizing temperature will change
(5) very different because the number of plateaus will change

(Questions 15 - 21)

The response that a plant makes to a stimulus is called a tropism. When the stimulus is gravity, the response is called geotropism. When the stimulus is light, the response is called phototropism. When the stimulus is water, the response is called hydrotropism. When the stimulus is pressure from a solid object, the response is called thigmotropism. If the plant's response is to grow or move toward the stimulus, this is called a positive tropism. If the plant's response is to grow or move away from the stimulus, this is called a negative tropism. For example, plants grown indoors near a sunny window nearly always tend to grow toward the window. This is an example of positive phototropism.

The complete mechanisms of tropisms are still the subject of study, but much is known already. It is believed that tropisms can be explained by chemical reactions. The stimulus causes certain chemicals to be produced in the plant (for example, auxin) which either cause or inhibit growth in a certain area of the plant thus making the plant grow toward or away from the stimulus.

Animals also respond to such basic stimuli as light and water and chemicals (chemotropisms). "In zoology, a tropism is an unavoidable response of an animal to some environmental stimulus involving the orientation of the body in relation to the causative factor. In very simple animals this reaction is common. Protozoans, for example, may always move toward or away from light, and even animals with organized nervous systems, may have some nerve paths associated in such a way that a given condition always evokes the same reaction." (Van Nostrand's Scientific Encyclopedia, third edition, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1958.)

More complex responses to similarly basic stimuli are often termed instincts. For example, it has been demonstrated clearly that certain birds navigate by the sun during migration. That is, the stimulus of the position of the sun and the time of day elicits the response of the direction of the bird's flight.

15. Some plants (for example, English ivy), tend to grow away from light. This is an example of

(1) positive geotropism (2) positive phototropism (3) negative geotropism
(4) negative phototropism (5) negative hydrotropism

16. The roots of certain plants tend to grow away from drier soil and towards moister soil. This is an example of

(1) positive hydrotropism (2) positive thigmotropism (3) positive geotropism
(4) negative hydrotropism (5) negative geotropism

17. When a morning glory grows up a post, curling around it and clinging to it as it grows, this is an example of a combination of

(1) positive geotropism and negative thigmotropism
(2) positive geotropism and positive thigmotropism
(3) negative geotropism and positive thigmotropism
(4) positive geotropism and positive phototropism
(5) negative geotropism and negative thigmotropism

18. If the leaves of certain plants such as mimosa are touched, they tend to close by folding both sides in toward the center. This is an example of a

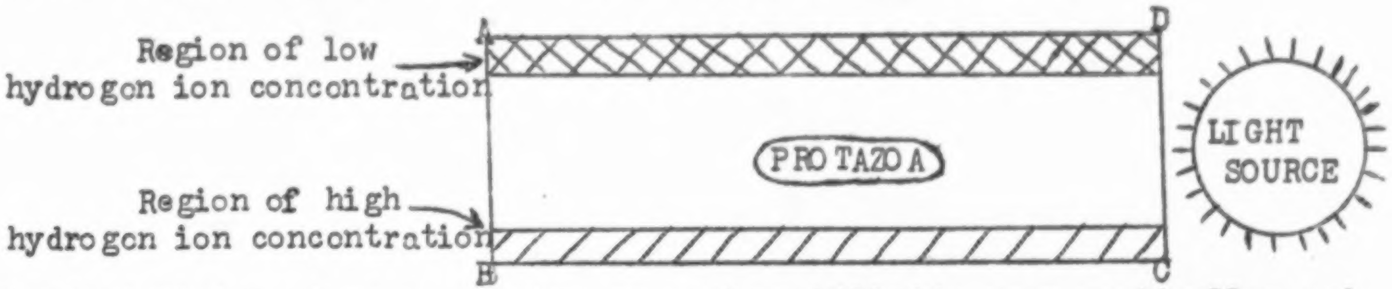
(1) hydrotropism (2) chemotropism (3) phototropism
(4) geotropism (5) thigmotropism

19. Many protozoa react to the hydrogen ion concentration (pH) of the medium in which they are placed. This is an example of

(1) chemotropism (2) hydrotropism (3) geotropism
(4) thigmotropism (5) phototropism

20. Suppose there is a protozoan with a negative phototropism and a positive chemotropism towards hydrogen ions. If you place a number of these protozoa in the system diagrammed below, they will probably

(1) not move (2) line up along side AD (3) line up along side BC
(4) congregate near point B (5) congregate near point D


A
D
Region of low hydrogen ion concentration
PROTAZOA
LIGHT SOURCE
Region of high hydrogen ion concentration
B
C

21. The fact that most trees growing on a steep hillside grow vertically, not perpendicular to the slope of the hill illustrates that geotropism

(1) is often accompanied by phototropism (2) is a response to gravity
(3) can be altered by the slope of the land (4) does not affect trees
(5) can be accompanied by thigmotropism

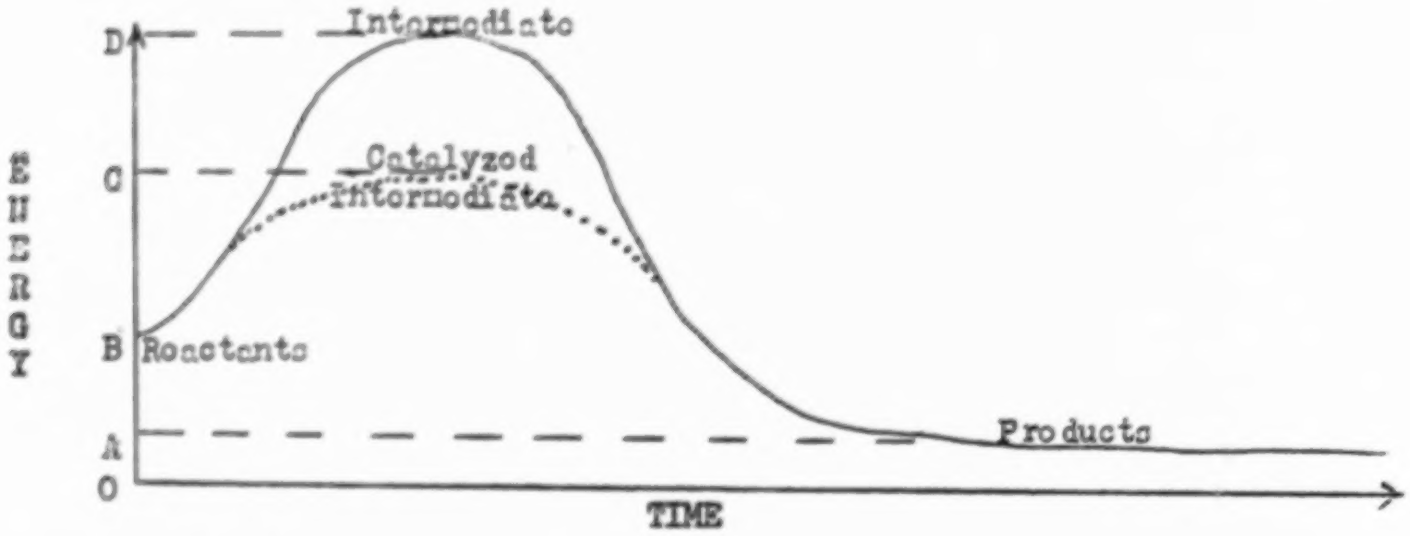
(Questions 22 - 28)

All systems of chemicals contain energy, part of which is due to the temperature of the system and part of which is due to the nature of the particular chemicals and compounds involved in the system. Systems of chemicals tend to change from conditions of higher energy to conditions of lower energy. Such changes often involve chemical reactions in which the products of the reaction are chemicals whose energy is less than that of the reactants.

Before a chemical reaction can take place, however, it is usually necessary for a relatively high energy intermediate to be formed by combination of the reactants. The energy needed to form this intermediate is called the activation energy and generally results from random thermal collisions of molecules. The intermediate breaks apart into the products of the reaction with a release of energy. If the amount of energy released is greater than the activation energy, then there is a net loss of energy from the system, leaving a lower energy system. Reactions of this type tend to take place.

If a positive catalyst is introduced into the system it will not affect the net loss of energy, only the rate of the reaction. Many catalysts act by complexing with the reactants to form an intermediate of lower energy than in the uncatalyzed reaction. This means that the activation energy of the catalyzed reaction is less than that of the uncatalyzed reaction. Therefore, the catalyzed reaction can proceed more rapidly. But, the release of energy when the catalyzed intermediate breaks apart into the products is also reduced (by just the same amount) so the net loss of energy to the system is the same in both cases.

Below is a graph of the energy changes of a chemical system as time proceeds during a reaction and the system goes from reactants to intermediate to products.



22. The activation energy of the uncatalyzed reaction is represented by distance

    (1) A-D (2) C-D (3) B-C (4) B-D (5) A-C

23. The activation energy of the catalyzed reaction is represented by distance

    (1) A-D (2) C-D (3) B-C (4) B-D (5) A-C

24. The loss of energy due to break down of the uncatalyzed intermediate is represented by distance

    (1) A-D (2) C-D (3) B-C (4) B-D (5) A-C

25. The difference in activation energy between the catalyzed and uncatalyzed reactions is represented by distance

    (1) A-D (2) C-D (3) B-C (4) B-D (5) A-C

26. The net loss of energy in the uncatalyzed reaction is represented by distance

    (1) D-O (2) A-C (3) A-O (4) A-B (5) A-D

27. The net loss of energy in the catalyzed reaction is represented by distance

    (1) D-O (2) A-C (3) A-O (4) A-B (5) A-D

28. If a different catalyst were used, which of the following must be true?

    (1) The rate of the reaction will be faster than with the original catalyst
    (2) The rate of the reaction will be slower than with the original catalyst
    (3) The activation energy of the new catalyzed intermediate will be less than that of the original catalyzed intermediate
    (4) The activation energy of the new catalyzed intermediate will be more than that of the original catalyzed intermediate
    (5) the net energy loss in the reaction will be unchanged

(Questions 29 - 35)

The velocity of an object is a vector quantity. This means that it has both magnitude and direction. For example, "50 miles per hour" is not a velocity, it is a speed, because direction is not specified, only magnitude is given. On the other hand, "50 miles per hour due east" is a velocity because both magnitude and direction are specified.

When the velocity of an object has been changed, the object is said to have been accelerated. There are three ways in which acceleration can take place: first, a change in the speed of an object, with no change in its direction of motion; second, a change in the direction of motion of an object, without a change in its speed; and third, changes in both speed and direction of motion of an object. It should be noted that the change in speed may be either a slowing down or a speeding up; both are accelerations. Precisely stated, acceleration is defined as a change in velocity over a period of time.

As an example of the first type of acceleration, consider a car starting from rest at one end of a long straightaway. The car is going to accelerate down the straightaway and, therefore, its direction will not change; only its speed will increase. Suppose that at the end of the first second it is going 5 mph. At the end of the second second it is going 10 mph. At the end of the third second it is going 15 mph.... until, at the end of the tenth second it is going 50 mph. This car is increasing its speed by 5 miles per hour per second. This type of acceleration is called linear acceleration because it is in a straight line with no change in direction of motion. When a linear acceleration is specified as a number with units, there is one distance unit ("miles" in the example) and there are two time units ("hours" and "seconds" in the example).

Other types of accelerations are called non-linear accelerations. One example is a ball being whirled around in a circle at the end of a string. The direction of motion of the ball is continuously changing (even though its speed may remain constant), therefore, it is being accelerated.

The only way an object can be accelerated is if a force is applied to the object. The force may be, among other possibilities, a physical push or pull. It may be a gravitational attraction. Or, it may be an electrical attraction or repulsion. Whatever it is, the size of the force determines the amount of acceleration. The larger the force, the greater the acceleration. The smaller the force, the less the acceleration. If the force is multiplied or divided by a given amount, the acceleration is multiplied or divided by that same amount. In other words, the acceleration is directly proportional to the magnitude of the force applied and in the direction in which the force acts.

The acceleration also depends on the mass of the object. The more massive the object, the less acceleration will be produced by a given force. For example, a 2 pound object will be accelerated only half as much as a 1 pound object if the same force is applied to the both of them. In other words, the acceleration produced by a specific force is inversely proportional to the mass of the object being accelerated.

The combination of these proportionalities is a statement of Newton's second law of motion: the acceleration of a body is directly proportional to the force applied to the body and inversely proportional to the mass of the body and in the direction of the application of the force.

29. Which of the following could NOT be a velocity?

(1) 25 feet per second up (2) 57.3 miles per minute east
(3) 437 miles per hour per second (4) 421 centimeters per second northeast
(5) 39.8 meters per hour down

30. Which of the following could be an acceleration?

(1) 27 miles per hour east (2) 63.9 feet per second per second
(3) 43 miles per foot per hour (4) 43 miles per foot per hour
(5) 67.2 minutes per foot per hour

31. A car starts from rest at time zero. It accelerates in a straight line. Its speed at the end of several of the first ten seconds of its acceleration are shown below:

second	0	1	2	3	4	5	6	7	8	9	10
speed	0 mph	7.5 mph	15 mph	?	30 mph	37.5 mph	?	?	?	67.5 mph	?

What is the probable speed of the car at the end of the seventh second?

(1) 57.5 miles per hour (2) 45 miles per hour (3) 50 miles per hour
(4) 52.5 miles per hour (5) 60 miles per hour

32. Assuming that it is constant, what is the acceleration of the car in question 31:

(1) 5 miles per hour per second (2) 7.5 miles per hour
(3) 7.5 miles per hour per second (4) 67.5 miles per hour
(5) 67.5 miles per hour per second

33. If the car in question 31 had been three times as massive but the accelerating force had been the same, what would the car's speed have been at the end of the fourth second?

(1) 30 miles per hour (2) 10 miles per hour (3) 15 miles per hour
(4) 90 miles per hour (5) 60 miles per hour

34. If a force of 10 units produces an acceleration of 25 feet per second per second of a particular body, a force of 5 units will accelerate the same body at:

(1) 5 feet per second per second (2) 20 feet per second per second
(3) 15 feet per second per second (4) 2.5 feet per second per second
(5) 12.5 feet per second per second

35. Object number one is accelerated by force number one at 25 yards per second per second. Object number two which is four times as massive as object number one is accelerated by force two which is twice as strong as force one. What is the acceleration of object number two due to force two?

(1) 100 yards per second per second (2) 6.25 yards per second per second
(3) 3.125 yards per second per second (4) 12.5 yards per second per second
(5) 50 yards per second per second

(Questions 36 - 42)

All living organisms require energy if they are to continue living. Most of the energy used by living organisms is derived from light. The light is changed to chemical energy and stored in various compounds to be released when needed by the organisms. This transformation and storage of energy takes place in those organisms which can perform photosynthesis. These include the green plants and some microorganisms.

Photosynthesis, in very simplified terms, involves the organism combining carbon dioxide and water to form, after many involved reactions, more complex compounds. The energy for these reactions is light which has been "captured" by specialized compounds, such as the chlorophylls. Then it is made available for the synthesis reactions. Those organisms which can perform the transformation of light energy into chemical energy are called "food producers" or, just "producers."

Not all organisms are producers. All animals and some plants (mushrooms, for example) cannot make their own food and must use food which has been synthesized by a producer. Such organisms are classified as "consumers."

Consumers are normally broken down into first-, second-, third-, and (sometimes) fourth-order consumers. A first-order consumer is one which feeds directly on a producer. For example, a field mouse which feeds on grasses is a first-order consumer. An organism which gets its energy by feeding on first-order consumers is a second-order consumer. An example of a second-order consumer would be a snake which feeds on field mice. A third-order consumer is an organism which feeds on second-order consumers. For example, an eagle preys on snakes.

Such a classification into orders of consumers is often helpful, but it must not be considered rigid. The eagle mentioned above may prey directly on the mice, making it a second-order consumer also.

There is one other general classification of organisms: decomposers. Decomposers are the final consumers. They are (with a few exceptions such as toadstools) primarily microorganisms. Decomposers feed on the dead bodies of all of the different producers and consumers. The result of the action of the decomposers is that most of the compounds which were in the dead bodies are freed and again can be consumed by producers to be reused in the manufacture and utilization of food.

A single sequence of consumption, such as from light, to grass, to mouse, to snake, to eagle, is called a "food chain." But, clearly this is not the only sequence in which any of these organisms is involved. Grass may be eaten by rabbits or by cows or sheep. Snakes may eat lizards or toads, or many other things. Eagles do not prey only on mice and snakes. When more than one sequence is considered and the interconnections among the chains are included, the resulting pattern is called a "food web."

36. Which of the following does NOT make use of chemical energy that was converted from light by a producer?

(1) a nuclear reactor (2) a coal burning steam engine
(3) a wood burning steam engine (4) an oil furnace (5) an automobile

37. Which of the following is NOT essential for photosynthesis?

(1) a light source (2) a water source (3) a carbon dioxide source
(4) an oxygen source (5) a chemical such as chlorophyll

38. Which of the following is a producer?

(1) a pig (2) a hawk (3) an algae (4) a human (5) a rabbit

39. Which of the following can NOT be a second-order consumer?

(1) a strictly herbivarous animal (2) a human (3) a venus flytrap
(4) a shark (5) a hawk

40. Which of the following could be a fourth-order consumer?

(1) a mouse (2) a plant (3) a cow (4) a shark (5) a rabbit

41. If you have ham and eggs and toast and butter and coffee for breakfast, you are acting as

(1) a first order consumer, only (2) a second-order consumer, only
(3) a first- and a second- and a third-order consumer
(4) only a second and third-order consumer (5) a third-order consumer only

42. Which of the following pairs of food chains may be directly interrelated to form a food web?

(1) grass to mouse to hawk AND algae to fish
(2) algae to fish to man AND berries to bears
(3) fish to penguin AND grass to cows
(4) grass to mouse to eagle AND plankton to whales
(5) trees to giraffes to lions AND plankton to whales

TEACHERS COLLEGE
COLUMBIA UNIVERSITY

ELEMENTARY SCIENCE SURVEY:

A Diagnostic Instrument

DO NOT WRITE ON THIS PAPER

Instructions: Answer all questions on the separate DIGITEK answer sheet by blackening the space corresponding to your choice of the best answer to each question or the best completion of each incomplete statement. Please do not write on this paper. If you wish to use scrap paper, you may. Be sure that your name is clearly printed in the proper spaces on the answer sheet.

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1. In science teaching, analogies are valuable to

    1. Help explain difficult concepts.

    2. Make our work with brighter pupils more challenging.

    3. Introduce mathematics into science teaching.

    4. Add spice to science teaching that is too often dull.

    5. Prove points that may not be acceptable to everyone.

2. Several students in your class rush up to you and say, "What would happen if you heated a balloon filled with air over a hot plate? Let's try it!" From the standpoint of good science instruction, your best procedure probably would be to

    1. Encourage them to try it immediately before their enthusiasm is cooled.

    2. First encourage and lead them to use what they know about the relationships between gases and temperature to think through what might happen and then try it.

    3. Suggest that it would be better to heat the balloon over a candle.

    4. Suggest that they try it at home.

    5. Tell them not to do it because the balloon would break.

3. Which of the following food groups is an especially good source of body building proteins?

    1. Vegetable and fruit group.

    2. Cereals group.

    3. Milk group.

    4. Meat and egg group.

    5. None of these.

4. In scientific investigation the major function of the hypothesis is

    1. To make certain that we consider all data.

    2. To open our minds to the many possible solutions to problems.

    3. To insure that the scientific method is used.

    4. To make it necessary to carry out controlled experiments.

    5. To serve as a tool for directing investigation and inquiry.

5. The north pole of an electromagnet may be reversed to south by

   1. Moving it closer to the earth's south pole.
   2. Unwinding some of the coil.
   3. Reversing the direction of flow of the electric current.
   4. Removing the core and reversing it.
   5. Passing south-seeking electrons through the coil.

6. There are two high tides every day at seaports. One high tide occurs when the port is on the side of the earth facing the moon. The second high tide occurs when the port is on the side of the earth

   1. Opposite the moon
   2. Opposite the sun.
   3. That has the most water.
   4. Not directly in line with the moon.
   5. Facing the sun.

7. To hear oncoming horses, Indians sometimes put an ear to the ground. Then they were able to hear the horses because

   1. Sound will travel better through soil than air because soil is more dense.
   2. Sound will travel better through soil than air because soil is less dense.
   3. Sound in soil travels more slowly because it is a transverse wave.
   4. The ground would block out extraneous noises.
   5. Actually they could not hear better by putting their ear to the ground.

8. Which of the following is an important factor in the process of evolution?

   1. Mutations.
   2. The great variations in climate that have occurred over the long span of geological time.
   3. The slow cooling of the earth over geologic time.
   4. Learning on the part of organisms.
   5. The life force in living protoplasm.

9. Most scientists now believe that the earth was formed

    1. As a result of a collision between the sun and another star.

    2. From the same dust cloud as the sun and the other planets.

    3. From a double star of the sun that exploded.

    4. At the same time that all of the rest of the universe was formed.

    5. When a star passed near the sun and some of the solar material that later became the planets was torn loose by the tidal forces.

10. If you want material for potting some plants in your classroom, where would it be best to take the children to dig for some?

    1. The clay bank of the school pond.

    2. The dirt and gravel along the school driveway.

    3. The sandbox.

    4. The bare dirt on the baseball diamond.

    5. The floor of the woods behind the school.

11. In general, the communicable diseases that plague mankind are transmitted from

    1. Insects to human beings.

    2. Animals to human beings.

    3. Human beings to animals.

    4. Human beings to human beings.

    5. Plants to human beings.

12. You wish to have your students see what human epithelial cells look like under the microscope. One way to obtain samples of these cells is to

    1. Use human tears.

    2. Use a small piece of a fingernail.

    3. Place a drop of blood on a slide.

    4. Gently cut off a piece of skin from the back of your hand.

    5. Scrape the inside of your mouth with a spoon.

13. In using a light and a globe to demonstrate the seasons, the students view the earth as if they were

    1. Outside the Milky Way Galaxy.
    2. At a point in space outside the earth's orbit.
    3. On the earth.
    4. On or near the moon.
    5. At one of the poles.

14. The carbon in the bodies of animals comes primarily from the

    1. Soil in their environment.
    2. Air they breathe.
    3. Water they bathe in.
    4. Food they eat.
    5. Water they drink.

15. Water has a number of unique and useful characteristics. One of the best ways to help students understand this is to

    1. Break down water into its component parts.
    2. Compare fresh water and sea water.
    3. Set up a terrarium.
    4. Have them read a mimeographed sheet on water and water resources.
    5. Experiment to compare water with another common liquid such as kerosene.

16. After a careful demonstration of the phases of the moon using a light and a sphere, one of your students asks, "In what part of the sky and at what time of the night can I best see the thin sliver of the new moon?" Your reply should be

    1. "In the west just after sundown."
    2. "I think you can figure that out for yourself."
    3. "There are many books and references about the moon in the library. Why don't you see if you can find the answer in one of those when we go to the library?"
    4. "Why don't we try part of the demonstration again and see if we can figure out the answer to your question?"
    5. Any one of the four above or even some other, depending on your objectives, who asked the question, how much time you have, etc.

17. We wish to keep the liquid in a bottle warm as long as possible. To reduce the amount of heat lost we might

    1. Paint it with black paint.
    2. Use a fan to blow air past it.
    3. Place it in water.
    4. Surround it with radial fins.
    5. Wrap insulating material such as rock wool around it.

18. Which of the following differentiates between living things and non-living things?

    1. Reproduction.
    2. Use of food.
    3. Movement.
    4. Use of oxygen.
    5. A combination of several factors such as those listed above.

19. A child asks you, "What is the difference between a rock and a mineral?" A correct reply would be.

    1. A rock has a definite chemical composition while a mineral does not.
    2. A rock is of organic origin while a mineral is not.
    3. A mineral has a definite chemical composition while a rock does not.
    4. A rock specimen will usually be bigger than a mineral specimen.
    5. A mineral is of organic origin while a rock is not.

20. Which of the following statements concerning our place in the universe is NOT true?

    ✓ 1. Our sun is one of a hundred million or more stars in the Milky Way Galaxy.
    ✓ 2. The earth is a planet of a star.
    ✓ 3. There may be more universes than the one we know.
    4. We are located in the central galaxy in the universe.
    5. The Milky Way Galaxy is one of several billion galaxies.

21. On the objective lens of the microscope there is printed "10X" and on the eyepiece there is printed "10X." This means that the material on a slide will be magnified

1. 0 times.
2. 10 times.
3. 20 times.
4. 100 times.
5. 1,000 times.

22. In using a light and a globe to demonstrate the seasons, it is important to

1. Change the intensity of the light to indicate the seasons.
2. Move the globe nearer to the light in the part of the orbit representing summer and farther away in the part of the orbit representing winter.
3. Change the position of the light during the demonstration.
4. Carry the globe around the light in as nearly a perfect circle as possible.
5. Keep the globe tilted so that the north pole of the globe is always pointing in the same direction.

23. The sound waves of middle "C" made by chimes and by a trumpet would

1. Sound the same.
2. Have waves of different vibrational frequencies.
3. Have different wave lengths.
4. Have the same wave lengths.
5. Have waves an octave apart.

24. One of the ways of preventing the spread of malaria is to spread a thin film of oil over the water in marshes and ponds. This serves to

1. Kill the malaria virus in the blood of the mosquito.
2. Kill the adult mosquito.
3. Kill the mosquito larva.
4. Prevent the adult mosquito from laying its eggs.
5. Prevent the drinking water from becoming contaminated with dust.

25. There is an intricate balance between many factors in the environment. Therefore, man should

1. Usually alter a variety of elements in the environment at the same time.

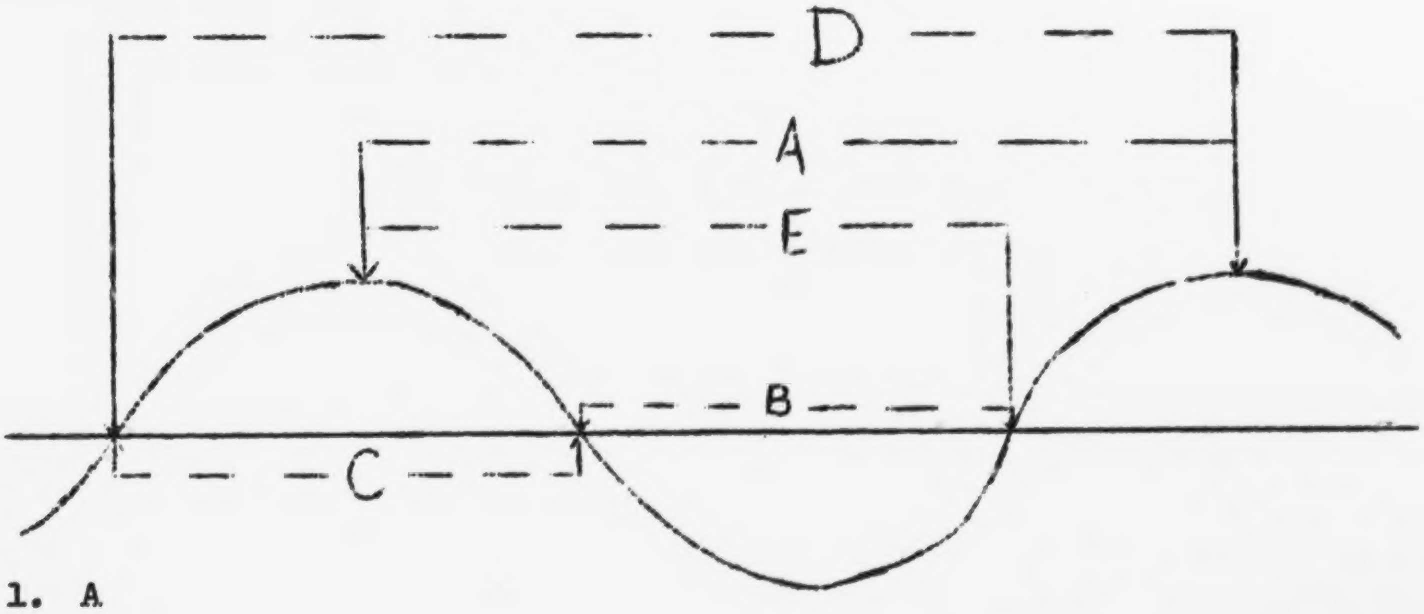
2. Not be too concerned about his actions because a balance will always be maintained.

3. Not kill any plants or animals because this upsets the balance.

4. Never upset the natural balance because by upsetting it he may destroy the natural resources he needs.

5. Try to use what he knows so that when he alters the environment undesirable effects will not take place.

26. The following is a diagram of a wave. One wave length would be represented by the letter



1. A
2. B
3. C
4. D
5. E

27. Which of the following is NOT usually used as a basis for modern weather forecasting?

1. Pressure and temperature tendencies.

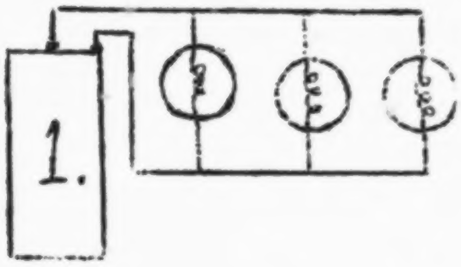
2. Upper air vorticities.

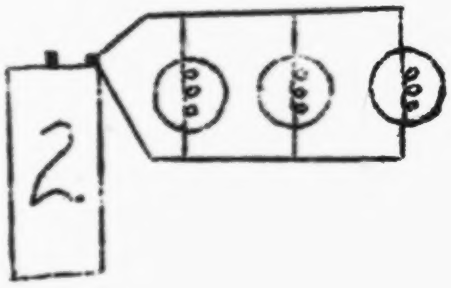
3. Radioactivity reports.

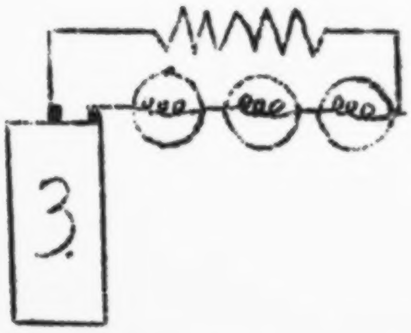
4. Maps of upper air winds.

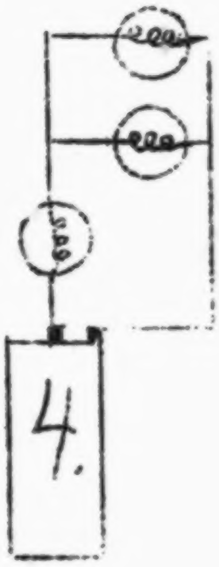
5. Carefully drawn maps of ground condition reports from many different stations.

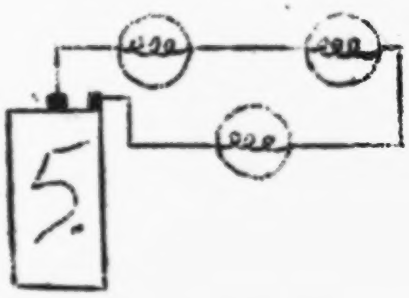
28. You wish to use a dry cell and flashlight bulbs and sockets to demonstrate a circuit in which one bulb can burn out but the others will continue to give off light. Which of the following circuits would you set up?











29. A student brings a magnet to school and asks, "Which is the north pole of the magnet?" One way he could find out would be to

1. See which end of the magnet has an N painted on it.
2. See which end of the magnet attracts iron filings.
3. Bring the magnet next to a compass needle, and the end of the magnet that repels the end of the compass needle that points north will be the north pole.
4. Bring the magnet next to a compass needle, and the end of the magnet that repels the end of the compass needle that points south will be the north pole.
5. Hang it from one end with a piece of tape and the north pole of the magnet will point south.

30. The moon in its orbit around the earth

1. Shines on the earth with special brilliance when it is between the sun and the earth.
2. Moves along with the earth in an orbit around the sun.
3. Eclipses the earth once every 29½ days.
4. Does not revolve.
5. Radiates light more brilliantly during some periods of the month than others.

31. You have your students stare at a piece of red paper for two or three minutes. When you remove the red paper they see green. You explain this phenomenon by saying

1. The receptors for red light in the retina tired while those for green did not. Therefore, the tired eyes would be more receptive to the green part of the spectrum.
2. The receptors for red light in the retina become stronger. Therefore, they tended to see the green part of the spectrum.
3. The white screen behind the red paper had changed to green because of the light shining through the red paper.
4. It really doesn't happen.
5. It was an optical illusion. Behind the red paper there was some green paper.

32. In scientific terms heat differs from temperature in that heat is

1. Measured with a thermometer.
2. A measure of the average kinetic energy of the molecules.
3. Not transmitted by conduction.
4. A measure of the total kinetic energy of a system.
5. Measured in degrees rather than calories.

33. A number of students in your school contract dysentery. It is possible this happened because

1. They were bitten by anopheles mosquitos.
2. They contracted it from a pet bird in the room.
3. They breathed in small droplets sprayed into the air when another person who had dysentery sneezed.
4. The food in the cafeteria was contaminated with bacteria carried by flies.
5. They were inoculated with unclean inoculation needles.

34. Scientists now believe that the earth is several

1. Thousand years old.
2. Hundred thousand years old.
3. Million years old.
4. Hundred million years old.
5. Billion years old.

35. It is suspected that a magnet has more than two poles. One way to find out would be to

1. Pull the magnet between the poles of a strong alnico magnet.
2. Sprinkle iron filings onto a piece of paper placed over the magnet and study the magnet lines of force.
3. Cut the magnet in two to see whether or not each of the resulting pieces has two magnetic poles.
4. Examine the magnetic domains with a magnifying glass to see whether they are lined up.
5. Tape a string to the center of the magnet and see whether or not it lines up in a north-south direction.

36. On March 21 (the vernal equinox) at noon the sun would be seen as directly overhead from a position on the

1. Arctic circle (66° 30' N. Latitude).
2. Tropic of Cancer (23° 30' N. Latitude).
3. Equator.
4. Tropic of Capricorn (23° 30' S. Latitude).
5. Antarctic circle (66° 30' S. Latitude).

37. In using a light and a sphere to demonstrate the phases of the moon, the students who see the phases see them as if they were located

1. At a point in space on the earth's orbit, but opposite the earth.
2. On or near the earth.
3. At one of the poles.
4. On or near the sun.
5. On or near the moon.

38. A key operation in measurement is

1. Using the same kind of measuring instrument that everyone else uses.
2. Using the metric system whenever possible.
3. Comparing the property being measured with some standard.
4. Using a measuring instrument with internationally accepted units.
5. Using the same measuring instrument whenever possible.

39. A satellite in orbit is always

1. Traveling in the same direction.
2. Traveling in a perfect circle around the body it is orbiting.
3. Maintaining velocities greater than escape velocity.
4. Being accelerated by a rocket engine.
5. Falling around the body it is orbiting.

40. Which of the following analogies is often used to explain how a satellite stays in orbit:

1. Galaxies marked on an expanding rubber balloon.
2. A cannonball shot from a mountaintop so that it will fall around the earth.
3. If A=B and C=B, then C=A.
4. A magnetic field as compared to an electric field.
5. The relationship of a small country to a big one.

41. What happens when a gas is heated?

1. The gas molecules are compressed.
2. The molecules of the gas all tend to move in the same direction.
3. New molecules of gas are generated.
4. The average velocity or speed of the gas molecules is increased.
5. The gas as a whole is heated but the individual molecules of the gas are unaffected.

42. Food is utilized in the body in somewhat the same way as fuel is oxidized in the burning of a candle. However, the body is able to obtain energy from foods at temperatures lower than those in a candle flame because

1. The food in the body is not really oxidized.
2. In the body there is reduction of fuel rather than oxidation.
3. There is a sudden, short rise in temperature at the moment of oxidation.
4. The actual temperatures in the cells are of the same order as those in a candle flame.
5. Enzymes act as catalysts in the oxidation of the food.

43. In solving a science problem we have to find the area of a surface that is 40.12 centimeters wide and 60.55 centimeters long. The correct statement of the area of this surface is

40.12
60.55 15
20 0
60

1. 2429.2660 square centimeters.
2. 2429.27 square centimeters.
3. 100.67 square centimeters.
4. 100.67 cubic centimeters.
5. 2429 square centimeters.

44. Which of the following is NOT one of the properties of water?

1. It is a solvent.
2. It is odorless.
3. It rusts iron and other metals.
4. It is colorless.
5. It contracts when it freezes.

45. If a chime bar were made shorter it would probably

1. Lose its chime-like tone.
2. Produce longer sound waves.
3. Make no musical sound.
4. Have a lower frequency sound.
5. Have a higher frequency sound.

46. An interesting project in elementary school science is growing crystals. However, one of your students found that his seed crystal dissolved when he put it into the solution. Probably, the seed crystal dissolved because the

1. Solution was super-saturated.
2. Solution was too cold.
3. Seed crystal was too warm.
4. Seed crystal was too cold.
5. Solution was too dilute.

47. Which of the following is NOT a simple machine?

    1. A shovel.

    2. A steering wheel.

    3. A file drawer.

    4. A block and tackle.

    5. A nut cracker.

48. In helping students to make a simple electric motor it is important to

    1. Have one brush make contact with one end of the armature wire while the other brush makes contact with a permanent magnet.

    2. Wind the wire in the armature coil always in the same direction.

    3. Keep the ends of the armature wires insulated.

    4. Connect the ends of the armature wire together.

    5. Have the ends of the field magnets nearest the rotating armature either both south poles or both north poles.

49. Which of the following is a major difference between sound waves and light waves?

    1. Sound waves transmit energy while light waves do not.

    2. Sound waves travel faster than light waves.

    3. Light waves will travel through transparent materials while sound waves will not.

    4. Light waves require a medium for transmission while sound waves do not.

    5. Sound waves vibrate in the same direction as the wave travels while the light waves vibrate at right angles.

50. Almost all of the energy we use on earth comes either directly or indirectly from two sources. These are the

    1. Earth and the moon.

    2. Sun and the moon.

    3. Sun and other stars.

    4. Earth and nuclear reactions on earth.

    5. Sun and nuclear reactions on earth.

51. You wish to have your students see the size of the pupils of their eyes become smaller. You divide your class into groups of two and ask them to look into their partner's eyes and then

1. Turn the lights on bright for a short time and then turn them off.
2. Have each of them blink as fast as they can.
3. Stare into each others pupils as hard as they can.
4. Turn the lights off for a short time and then turn them on as bright as possible.
5. Focus their eyes on some distant object.

52. A device designed specifically to intensify or increase electric current is

1. A radar set.
2. A resistor.
3. A diode.
4. An amplifier.
5. An oscilloscope.

53. Energy has been defined as

1. The amount of difficulty encountered in attempting to move an object.
2. The ability to do work.
3. The strength of an object.
4. A force acting through a distance.
5. The total velocity of the molecules in an object.

54. In viewing an eclipse of the moon (a lunar eclipse), the teacher should suggest that students

1. Note the curved edge of the shadow of the earth.
2. Hold smoked glass or photographic negatives in front of their eyes.
3. Note the craters on the moon.
4. Note the corona which is only visible during a lunar eclipse.
5. Note the shadows of the mountains and high buildings on the earth.

55. An airplane can stay aloft because

1. The propellers or jets are pulling the plane up and forward faster than it can fall.

2. All objects in a fluid, such as air, are lifted by a force equal to the weight of the fluid displaced by the object and this force is enough to keep the plane aloft.

3. The propellers or jets are tilted slightly so that they push down and the plane stays up as an equal and opposite reaction according to Newton's third law.

4. The air flows faster over the curved upper surface of the wing and so exerts less pressure down than is exerted up by the slower flowing air underneath.

5. There is a vacuum created above the wing and this means the pressure up on the wing is greater than the pressure down on the wing.

56. You wish to demonstrate how sound waves travel. One of the best ways to do this is to use a

1. Sound meter.

2. Coiled spring such as a "slinky."

3. Dangling rope.

4. Megaphone.

5. Telephone.

57. Jack said, "Sound travels in waves. Here is what these waves are like." Which of the following characteristics of sound waves that Jack stated is NOT correct?

1. Sound waves travel slower than light waves.

2. Sound waves are like waves on the surface of water.

3. Sound waves are compressional waves.

4. Sound waves will travel through metals and water as well as through air.

5. Sound waves will not travel through a vacuum.

58. Which of the following lists places these four components of most higher living organisms in order of complexity from least to most complex?

1. Tissues, cells, organs, systems.

2. Cells, tissues, systems, organs.

3. Systems, organs, tissues, cells.

4. Cells, organs, systems, tissues.

5. Cells, tissues, organs, systems.

59. In a controlled experiment

1. It is desirable that none of the factors be varied.

2. Several factors are varied to study the effect of changing all of them.

3. All factors are controlled but one, so that the effect of changing one factor can be studied.

4. A different type of observation should be used for each of the variables being studied.

5. Time cannot be one of the variables.

60. In which of the following does man **NOT** make direct use of living or once living material?

1. Irrigation.

2. Heating.

3. Eating.

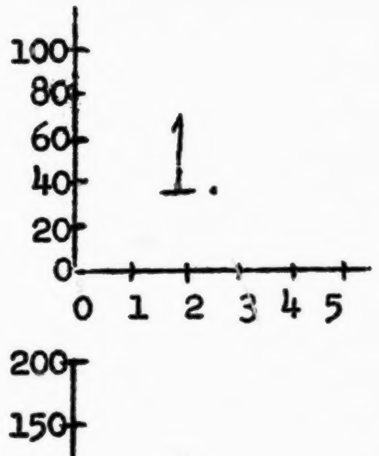
4. Clothing.

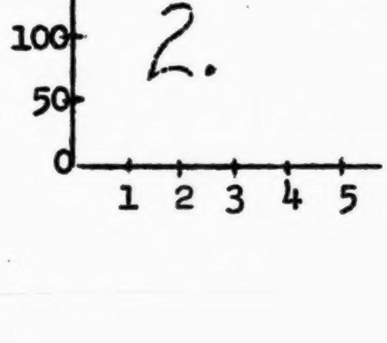
5. Book printing.

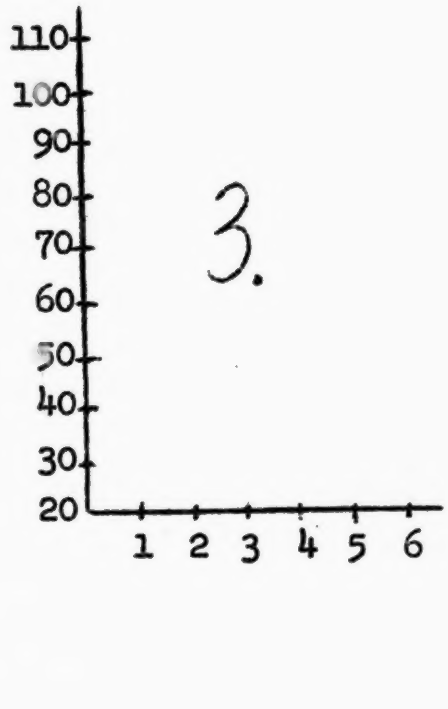
61. A student has measured the height to which a ball bounces on successive bounces and obtained the following data:

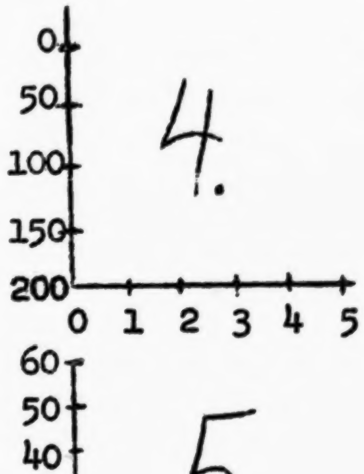
1st bounce	100	centimeters
2nd bounce	81	centimeters
3rd bounce	60	centimeters
4th bounce	39	centimeters
5th bounce	17	centimeters

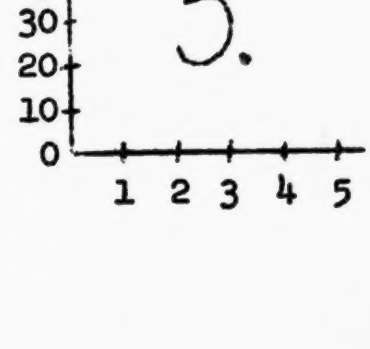
In graphing his data which of the following coordinate systems should he use:











62. Which of the following is NOT a method for controlling the spread of disease through a community?

1. Homogenizing milk.
2. Inspecting restaurants.
3. Processing sewage.
4. Vaccinating children.
5. Sterilizing bottling equipment.

63. On a field trip you discover a seam of igneous rock between two layers of the same fossiliferous rock. The most probable explanation for the location of the igneous rock is

1. The three layers were laid down simultaneously.
2. The three layers were laid down simultaneously, but what is now igneous was then something else and due to differential heating became changed.
3. The three layers were laid down sequentially from bottom to top and under terrific heat and pressure changed into what you see today.
4. The three layers were laid down sequentially from bottom to top.
5. The igneous materials intruded into the fossiliferous rock while it was still fluid enough to flow.

64. One of the features that differentiates an animal from a plant is that

1. Animal cells have a nucleus while plant cells do not.
2. Animals move but plants do not.
3. Animals are sensitive to stimuli while plants are not.
4. Animal cells do not have a cell wall while plant cells do.
5. Animals reproduce sexually while plants can not.

65. The pressure of the outside air can be made to crush a metal can. One way to demonstrate this is to

1. Fill the can with water. Allow the water to run out of the can through a long piece of rubber tubing.
2. Take the can to high altitudes in an unpressurized airplane.
3. Fill the can with air and then take it down into the deepest hole you can find where the air pressure is greater.
4. Put the can under a bell jar and pump the air out.
5. Put a little water in the can. Tightly cap the can. Place it on a hot plate and boil it as furiously as possible.

66. An important concept in ecology is that of the "climax" condition. By "climax" condition we mean

1. A condition of collapse as a result of the imbalance of population.
2. The condition brought about by intensive agriculture.
3. The condition that leads to radical change in the plant and animal population of an area.
4. The condition of greatest activity in the plant and animal community.
5. A condition that will exist indefinitely if no major changes take place in the environment.

67. On a field trip you and your students find, near the top of a hill, fossils of organisms that must have lived in the oceans. The probable explanation for this is

1. The fossils were transported to the hilltop by some geologic agent.
2. The entire earth must have been under the ocean.
3. The organisms must have been capable of traveling from the oceans to this hilltop.
4. At one time these organisms must have been capable of living on land.
5. The rocks near the top of the hill must once have been under water.

68. Elementary school students can make a simple fire extinguisher from

1. Lemon juice and aluminum.
2. Ammonium chloride solution and a nickel.
3. Vinegar and baking soda.
4. Zinc and sulfuric acid.
5. Any weak acid and any weak base.

69. For species of plants and animals to survive it is important that they

1. Have adaptations that will allow some individuals to survive until they can reproduce.
2. Have as wide a range of adaptations as possible.
3. Reproduce sexually.
4. Have a long life span.
5. Be adapted to live in a wide variety of environments.

70. The atmosphere that surrounds the earth consists mainly of

1. Nitrogen and oxygen and carbon dioxide.
2. Oxygen and hydrogen.
3. Carbon and hydrogen.
4. Nitrogen and hydrogen.
5. Oxygen and carbon dioxide and water vapor.

71. A Bunsen burner is burning with a very yellow flame. To get a hot blue flame it will be necessary to

1. Clean out the burner.
2. Allow more air to enter the burner.
3. Shut off the burner and relight it.
4. Change the tip on the burner.
5. Allow more fuel to enter the burner.

72. Some of your students wish to make an insect collection. The chemical often used as a killing agent is

1. Camphor.
2. Cyanic acid.
3. Carbon tetrachloride.
4. Chlorine.
5. Plaster of paris.

73. The spectrum of light from certain distant galaxies is shifted toward the red end of the spectrum because

1. This light travels faster than ordinary light.
2. As light travels over great distances it tends to become redder.
3. These distant galaxies are probably younger than ours.
4. These distant galaxies are moving away from us at tremendous speeds.
5. This light was redder in the first place.

74. You wish to obtain a supply of microbes for your pupils to examine under the microscope. The following is a common way of obtaining microbes for study.

1. Obtain a sample of river water near a point where a sewer empties into the river.
2. Take a sample of tap water.
3. Place some hay in water and allow it to stand for a couple of weeks.
4. Allow some water to stand in warm sunlight for several days.
5. First contaminate some agar plates and then place a penicillin disk on the agar plate.

75. Of the following, which is NOT necessary for a fire to continue burning?

1. Ample fuel.
2. Ample supply of carbon dioxide.
3. Temperature above kindling temperature.
4. Contact between or mixing of fuel and oxygen.
5. Ample supply of oxygen.

76. Which of the following has the LEAST influence in shaping and reshaping the earth's surface?

1. Weather.
2. Glaciation.
3. Meteor showers.
4. Vulcanism.
5. Pressure within the earth.

77. In what stage of the water cycle do we make the most use of water?

1. While it is in the atmosphere.
2. After it falls as rain and before it reaches the ocean.
3. We make about the same amount of use of it in each of the stages of the cycle.
4. After it leaves the oceans and before it falls as rain.
5. After it reaches the ocean and before it reaches the atmosphere.

78. In most classification systems objects are classified on the basis of certain properties. To be useful the classification system should be based on types of properties that

1. Vary with time.
2. Are possessed by relatively few of the objects to be classified.
3. Are possessed by all of the objects to be classified.
4. Can only be detected by people who are familiar with the classification system.
5. Have been accepted by scientific organizations as bases for classification.

79. How does lime that is spread on soil often improve plant growth?

1. It kills certain harmful fungi.
2. It provides calcium for the plants.
3. It kills certain harmful bacteria.
4. It neutralizes basic soil.
5. It neutralizes acidic soil.

80. You want to demonstrate to your students how to make a simple electric cell. One of the best and safest ways of doing this is by using the following materials:

1. Zinc, sulfuric acid and plastic.
2. Ammonium chloride solution and two carbon rods.
3. Zinc, ammonium chloride solution and a carbon rod.
4. Sulfuric acid and two pieces of lead.
5. ~~Ammonium chloride solution and two carbon rods.~~

81. The angle between an incident beam of light and a plane mirror is 35°. The angle between the mirror and the reflected beam of light would be

1. 55°
2. 35°
3. 325°
4. 305°
5. Impossible to predict.

82. Which of the following would be a practical way of demonstrating the presence of a very small electric current in a wire?

1. Carefully, but quickly, touch the wire to see if you get a small electric shock.
2. Wind the wire around a nail and see if the nail will attract a paper clip.
3. Scratch the two ends of the wire together to see if you get a spark.
4. Connect the ends of the wire to a watt-hour meter.
5. Wind the wire around a compass. If there is a current in the wire, the compass needle will line up at right angles to the coil of wire.

83. Which of the following is an important generalization concerning machines?

1. With all machines, lubricants are necessary for effective operation.
2. All machines would operate if we could completely eliminate friction.
3. Because of friction we always have to put more work into a machine than we get out of it.
4. The major advantage of a machine is that we can get more work out of it than we put into it.
5. The output force is always less than the input force.

84. One of your students has strong religious beliefs and feels that the discussion of such hypotheses concerning the origins of the universe as the "steady state hypothesis" and the "big bang hypothesis" are inimical to her belief that God created the universe. As a teacher what response should you make?

1. Point out to the student the much stronger evidence that can be marshaled to support scientific hypotheses concerning the origins of the universe.
2. Alter the remainder of the work in science so that material that might be questioned by people of various religions would not be included.
3. It is best to ignore the religious beliefs of students.
4. Suggest that the student should become aware of the various views and approaches to the explaining of the origins of the universe including both the religious and the scientific approaches to explanation.
5. Discuss with the student the pertinent sections of religious books and try to show how these sections are consistent with scientific hypotheses.

MEASURING MEANING

Name:_______________ Code #_____ Supervisor:_______________

INSTRUCTIONS

The purpose of this study is to measure the meanings of certain things to various people by having them judge these things against a series of descriptive scales. In taking this test, please make your judgments on the basis of what the things mean to you. On each page of this booklet you will find a different concept to be judged and beneath it a set of scales. You are to rate the concept on each of the scales in order.

Here is how you are to use these scales: If you feel that the concept at the top of the page is very closely related to one end of the scale, you should place your cross-mark as follows:

fair_X_:___:___:___:___:___:___unfair OR fair___:___:___:___:___:___:_X_unfair

If you feel that the concept is quite closely related to one or the other end of the scale (but not extremely), you should place your cross-mark as follows:

fair___:_X_:___:___:___:___:___unfair OR fair___:___:___:___:___:_X_:___unfair

If the concept seems only slightly related to one side as opposed to the other side (but is not really neutral), then you should check as follows:

fair___:___:_X_:___:___:___:___unfair OR fair___:___:___:___:_X_:___:___unfair

The direction toward which you check, of course, depends on which of the two ends of the scale seem most characteristic of the thing you're judging. If you consider the concept to be neutral on the scale, both sides of the scale equally associated with the concept, or if the scale is completely irrelevant, unrelated to the concept, then you should place your cross-mark in the middle space:

fair___:___:___:_X_:___:___:___unfair

IMPORTANT:

1. Place your cross-marks in the middle of spaces, not on the boundries:

fair___:_X_:___:___:___:___X___unfair

THIS NOT THIS

2. Be sure you check every scale for every concept - do not omit any.

3. Never put more than one mark on a single scale.

4. Do not look back and forth through the items, but try to make each item a separate and independent judgment.

5. Work at fairly high speeds. Do not worry over items, but instead check your first impression, your immediate "feelings" about the item. On the other hand, don't be careless, because we are interested in your *true* impressions.

*MYSELF AS A SCIENCE TEACHER
SCIENTIFIC INVESTIGATIONS BY PUPILS
MY ELEMENTARY SCHOOL
PROCESS-CENTERED ACTIVITIES
INDIVIDUALIZED SCIENCE ACTIVITIES
DISADVANTAGED CHILDREN
"DIFFICULT" STUDENTS
MY TEACHING SKILLS AND TECHNIQUES
SCIENCE INSTRUMENTS AND MATERIALS
SCIENTIFIC KNOWLEDGE

valuable ___:___:___:___:___:___:___ worthless

simple ___:___:___:___:___:___:___ complicated

unpleasant ___:___:___:___:___:___:___ pleasant

familiar ___:___:___:___:___:___:___ strange

dull ___:___:___:___:___:___:___ interesting

unpredictable ___:___:___:___:___:___:___ predictable

important ___:___:___:___:___:___:___ unimportant

mysterious ___:___:___:___:___:___:___ understandable

hard ___:___:___:___:___:___:___ easy

chaotic ___:___:___:___:___:___:___ ordered

* Note: For the copy used in the testing sessions, each concept occupied a separate page. The order of the pages was randomized, but the scale sets were in the same order for each concept.

NDEA INSTITUTE IN SCIENCE

TEACHER-PARTICIPANT EVALUATION OF THE EFFECTIVENESS OF THE INSTITUTE

Below is a listing of some of the objectives of the NDEA Institute, including some of the methods and procedures emphasized in reaching these goals. Please rate each of these statements in terms of the degree of effectiveness you think the Institute has had with you in meeting these objectives. Blacken the space on the answer sheet that corresponds to the number (1 2 3 4) which best describes, in your opinion, how effective the Institute has been:

1 The Institute has had a NEGATIVE EFFECT on
2 The Institute has had NO EFFECT on
3 The Institute has had SOME POSITIVE EFFECT on
4 The Institute has had OUTSTANDING POSITIVE EFFECT on

Please be sure to rate each of the goals. Each goal is preceded by a question number. In filling in the answer sheet, be careful to indicate your choice in the appropriate blank space. You may erase, but be sure to do so completely.

1. Your knowledge of the growth of animals and plants.
2. Your knowledge of heat and its effects upon the phases of matter.
3. Your knowledge of motion and its relation to frames of reference.
4. Your knowledge of the adaptive responses of plants and animals.
5. Your knowledge of temperature and thermometers.
6. Your knowledge of the earth and its relation to the sun.
7. Your familiarity with available science materials, methods, procedures and sources of information.
8. Your ability to distinguish among a variety of teaching approaches, e.g., field experiences, demonstrations, experiments, etc.
9. Your ability to evaluate teaching experiences to determine how well it will demonstrate a specific science concept.
10. Your ability to select the appropriate teaching experience through which pupils may achieve specific science concepts.
11. Your ability to exploit extant materials for presenting concepts to pupils.
12. Your ability to use home and community experiences to develop science concepts.
13. Your ability to scan science trade books for appropriate and pertinent concepts.
14. Your ability to examine trade books for the purpose of abstracting the content.
15. Your ability to write explanations of science concepts.
16. Your ability to coordinate the use of textual and laboratory materials.
17. Your ability to plan simple experiences to teach science concepts to pupils.
18. Your skill in designing, constructing and/or assembling simple materials.
19. Your skill in using models to study and explain science phenomena.
20. Your skill in using science instruments and materials.
21. Your ability to direct and focus attention on the problem being considered.
22. Your ability in making the topic or aim of the lesson clear to the pupils.
23 Your ability to plan and organize individual and/or small group observation of a natural phenomenon.
24. Your skill in leading individual and/or small group observations and discussions of a natural phenomenon.
25. Your ability to increase the opportunities for pupils to collect data and make observations.
26. Your skill in raising pertinent questions about the findings.
27. Your ability to encourage pertinent questions about the findings from pupils.
28. Your ability to exploit and expand pupils' findings, examples and inquiries.
29. Your ability to collect, organize and interpret simple science data.
30. Your skill in leading and conducting discussions of the findings.
31. Your ability to conduct summarizations that answer the original questions.
32. Your ability to conduct summarizations that raise new, but related, questions.
33. Your skill in evaluating the extent to which pupils have mastered a concept.
34. Your enjoyment of science.
35. Your ease and confidence with materials and ideas in teaching science to pupils.

Imagine another group of teachers similar to yourself. All things considered, would you be in favor of this Institute being continued, discontinued, or modified for them? Please check one of the alternatives and explain the reasons for your decision:

Continued:

Discontinued:

Modified:

Please list below the specific areas, problems or objectives that you personally received most help in, least help in:

Most Help In:

Least Help In:

Certainly no program is perfect. We would welcome any suggestions for the improvement of this type of Institute program. Please try to be as specific as possible in describing the strengths and weaknesses of your summer Institute experiences.

If you wish, please sign your name

____

NDEA INSTITUTE IN SCIENCE

SUPERVISOR-PARTICIPANT EVALUATION OF THE EFFECTIVENESS OF THE INSTITUTE

Below is a listing of some of the objectives of the NDEA Institute, including some of the methods and procedures emphasized in reaching these goals. Please rate each of the following statements in terms of the degree of effectiveness you think the Institute has had in meeting these objectives with the teacher-participants in your group. Circle a number (1 2 3 4) which best describes your general opinion of how effective the Institute has been:

1 The Institute has had a NEGATIVE EFFECT on
2 The Institute has had NO EFFECT On
3 The Institute has had SOME POSITIVE EFFECT on
4 The Institute has had OUTSTANDING POSITIVE EFFECT on

1 2 3 4 Teachers' knowledge of the growth of animals and plants.
1 2 3 4 Teachers' knowledge of heat and its effects upon the phases of matter.
1 2 3 4 Teachers' knowledge of motion and its relation to frames of reference.
1 2 3 4 Teachers' knowledge of the adaptive responses of plants and animals.
1 2 3 4 Teachers' knowledge of temperature and thermometers.
1 2 3 4 Teachers' knowledge of the earth and its relaiion to the sun.
1 2 3 4 Teachers' familiarity with available science materials, methods, procedures and sources of information.
1 2 3 4 Teachers' ability to distinguish among a variety of teaching approaches, e.g., field experiences. demonstrations, experiments, etc.
1 2 3 4 Teachers' ability to evaluate teaching experiences to determine how well it will demonstrate a specific science concept.
1 2 3 4 Teachers' ability to select the appropriate teaching experience through which pupils may achieve specific science concepts.
1 2 3 4 Teachers' ability to exploit extant materials for presenting concepts to pupils.
1 2 3 4 Teachers' ability to use home and community experiences to develop science concepts.
1 2 3 4 Teachers' ability to scan science trade books for appropriate and pertinent concepts.
1 2 3 4 Teachers' ability to examine trade books for the purpose of abstracting the content.
1 2 3 4 Teachers' ability to write explanations of science concepts.
1 2 3 4 Teachers' ability to coordinate the use of textual & laboratory materials.
1 2 3 4 Teachers' ability to plan simple experiences to teach science concepts to pupils.
1 2 3 4 Teachers' skill in designing, constructing and/or assembling simple materials.
1 2 3 4 Teachers' skill in using models to study & explain science phenomena.
1 2 3 4 Teachers' skill in using science instruments and materials.
1 2 3 4 Teachers' ability to direct & focus attention on problem being considered.
1 2 3 4 Teachers' ability in making the topic or aim of the lesson clear to the pupils.
1 2 3 4 Teachers' ability to plan & organize individual and/or small group observation of a natural phenomenon.
1 2 3 4 Teachers' skill in leading individual and/or small group observations & discussions of a natural phenomenon.

1 2 3 4 Teachers' ability to increase the opportunities for pupils to collect data and make observations.
1 2 3 4 Teachers' skill in raising pertinent questions about the findings.
1 2 3 4 Teachers' ability to encourage pertinent questions about findings from pupils.
1 2 3 4 Teachers' ability to exploit & expand pupils' findings, examples and inquiries.
1 2 3 4 Teachers' ability to collect, organize & interpret simple science data.
1 2 3 4 Teachers' skill in leading & conducting discussions of the findings.
1 2 3 4 Teachers' ability to conduct summarizations that answer the original questions.
1 2 3 4 Teachers' ability to conduct summarizations that raise new, but related, questions.
1 2 3 4 Teachers' skill in evaluating the extent to which pupils have mastered a concept.
1 2 3 4 Teachers' enjoyment of science.
1 2 3 4 Teachers' ease & confidence with materials & ideas in teaching science to pupils.

All things considered, would you be in favor of this Institute being continued, discontinued or modified next year to include another group of supervisors and teacher-participants similar to yourselves? Please check one of the alternatives and state the reasons for your choice:

Continued: ______________

Discontinued: ______________

Modified: ________________

Please list and describe below the specific areas, problems and/or objectives that you feel the teacher-participants received most help in, least help in:

Most Help In	Least Help In

In what ways do you think the supervisors were most helpful in, least helpful in:

Most Helpful In	Least Helpful In

Certainly no program is perfect; we would welcome any suggestions for the improvement of this type of Institute program. Please try to be as specific as possible in describing the strengths and weaknesses of the summer Institute experiences. (Use the back of this page.)

NDEA INSTITUTE IN ELEMENTARY SCIENCE
SUPERVISOR-PARTICIPANT CLASSROOM OBSERVATION SCHEDULE

Teacher: ____________ School(boro): ______ Grade & Class: _____ Room: _____ Date: _____
Time(From,To): ______, ______ Observer's Name: ____________

1. Topic: What was the science lesson about?
(Please specify)

2. Was the topic (please check): New to the pupils? ____
Or, had they worked on the topic for a short time? ____
Or, had they worked on the topic for a long time? ____

3. In introducing the science lesson, did the teacher use any of the following? Please check & specify, indicating if these were teacher-made(T), pupil-made(P), commercial(C)

______ Materials (rocks, magnets, batteries, straws.)
______ Instruments (thermometers, scales...)
______ Textbooks
______ Individualized printed matter (workbooks...)
______ Chalkboard, bulletin board, charts, etc.
______ Verbal introduction only
______ Other (specify)

4. The major part of the lesson consisted of (please check):

______ Lecture by the teacher
______ Demonstration by the teacher
______ Preparation for pupil activity
______ Pupil activity
______ Discussion

5. During the lesson, did the teacher use: (Please check. Were these teacher-made(T), pupil-made(P), commercial(C)?

______ Models
______ Materials
______ Instruments
______ Textbooks
______ Other printed material
______ Chalkboard, bulletin board, charts, etc.
______ Other (specify)

6. During the lesson were the pupils asked for their own observations? Yes: _____ No: _____

7. During the lesson, were the pupils asked to help with the demonstration? Yes: ____ No: ____

8. During the lesson, were the pupils given an opportunity to handle materials & equipment? Yes: ___ No: ___

9. During the lesson, did the pupils have an opportunity to collect, gather data? Yes: ___ No: ___
Were the data primarily: Descriptive ______
Quantitative ______

10. During the lesson, did the pupils have an opportunity to organize the data? Yes: ___ No: ___
Were the data organized: Descriptively ______
Quantitatively ______

11. During the lesson, were the pupils asked for examples? Yes: ___ No: ___
Did the teacher exploit and expand these examples?
Yes: ___ No: ___

12. Please check which of the following describes the degree to which the teachers gave directions and instructions for the safety of pupils and/or the care and use of materials and equipment:

______ No instructions given
______ Too few instructions given
______ Adequate instructions
______ Good instructions
______ Too many instructions given

13. Did you detect any gross errors in the teacher's information or knowledge about science?
Yes: ___ No: ___ Could not determine: ____

In your opinion, were these "errors" due to simplification of the topic for this grade level?
Yes:___ No:___ Could not determine:___

14. Please indicate the degree to which the teacher integrated the science lesson with other subject matter:

___No integration
___Poor integration
___Adequate integration
___Good integration
___Overly integrated

Specify which, if any, subjects were stressed:

15. Please indicate the frequency with which the teacher questioned the pupils:

___Too rarely
___Few questions
___Several questions
___Questioned often
___Too frequently

16. When the teachers asked questions, did they tend to be:

___Factual and definitional
___Procedural
___Explanative and predictive
___Disciplinary and attention-getting

17. How did the lesson end? (Please describe briefly)

Were the original questions answered? Yes:___ No:___
Were new questions raised? Yes:___ No:___

18. Circle the scale number that best describes the summation of the lesson in relation to the next science lesson.

1	2	3	4	5
Terminal		Leads to next science activity		Generates too many questions

19. Indicate how critical the teacher was, in general, of pupils' examples:

1	2	3	4	5
Intolerant, overly critical		Very tolerant, appropriately critical		Uncritical, overly tolerant

20. Indicate your impression of how the teacher reacted to questions from the pupils:

1	2	3	4	5
Did not allow ques.	Discouraged	Neutral	Accepted	Encouraged questions

21. Indicate: TEACHER'S SKILL IN INTRODUCING LESSON.

1	2	3	4	5
Very unskilled	Some skill	Average skill	Above average	Highly skilled

22. Indicate: TEACHER'S SKILL IN CONDUCTING LESSON.

1	2	3	4	5
Very unskilled	Some skill	Average skill	Above average	Highly skilled

23. Indicate: TEACHER'S SKILL IN TERMINATING LESSON.

1	2	3	4	5
Very unskilled	Some skill	Average skill	Above average	Highly skilled

24. Indicate: TEACHER'S SKILL IN USING MATERIALS AND EQUIPMENT (TECHNIQUE).

1	2	3	4	5
Very unskilled	Some skill	Average skill	Above average	Highly skilled

25. Indicate: Teacher's degree of POISE.

1	2	3	4	5
Ill at ease	Uncertain	At ease	Confident	Highly confident

26. Indicate: Teacher's GENERAL ATTITUDE (toward teaching science to this class).

1	2	3	4	5
Negative		Bland		Enthusiastic

27. Indicate: Extend of PUPIL INVOLVEMENT.

1	2	3	4	5
Restless	Bored	Passive	Involved	Engrossed

28. Indicate: Overall QUALITY OF LESSON:(Use back of page to explain criteria you used in judging overall quality.

1	2	3	4	5
Poor		Good		Excellent

Teacher: ____ School(Boro): ____ Date: ____ Observer: ____
Grade & Class: ____ Room: ____ Time, from: ____ to: ____ No. Pupils: ____

Aim for P (specify sequentially): ____

INTRODUCTION

Teacher used:	cl.rm.	school	home	community	other
materials					
instruments					
textbook					
other print					
visual aids					
verbal only					
verbal integration					

TOPIC (Specify): ____
New: ____ Young: ____ Old: ____

AIM:

1	2	3	4	5
T imposed				T elicited

1	2	3	4	5
T aim vague to P				T aim clear to P

1	2	3	4	5
T introd inappro to aim		Introd not applicable		Very appro to aim

PLANNING

T activity: ____ P activity: ____ P experiment: ____

P opportunity for planning:

1	2	3	4	5
None	Very little	Some	A lot	Too much

T skill in conducting planning:

1	2	3	4	5
T un-skilled		Adequate skill		T very skilled

GROUPING: Whole class? ____
Groups (No. in each) ____

1	2	3	4	5
Inappro to aim		Makes no difference		Very appro

DATA

P opportunity to collect data, make observations:

1	2	3	4	5
T only	Little	Some	A lot	Too much

Descriptive? ____
Quantitative? ____

P opportunity to organize systematically:

1	2	3	4	5
T only	Little	Some	A lot	Too much

Descriptive? ____
Quantitative? ____

Interpretation:
Dogmatic, absolute: ____
Probabilistic: ____
Inconclusive, not enough info: ____

by T primarily: ____
by P primarily: ____
jointly: ____

TEACHER behavior during: A Discussion/Lecture, B Demonstration, C Preparation for P activity, D During P activity, E End of lesson

T P C Model	T made material	P made material	Commercial material	Instru-ments	Text	Other printed materials	Blk. Bd. Bul. Bd. Charts,etc					
								# of different types				
								1 t unprepared	2	3 some prep	4 adequate	5 very well
								1 t unskilled	2	3 adequate skill	4	5 t highly skilled
								1 aids inappro to situation	2	3 aids irrel-evant	4	5 aids appro to situation
								1 no integration w/other subj.	2 poor	3 adequate	4 good	5 too much
								1 none	2 too few instructions	3 adequate	4	5 too many
								1 no p phys. involvement	2	3 some p phys. involvement	4	5 all p phys. involved
								1 some content errors	2	3 errors due to simplification	4	5 no content errors

HOW LESSON ENDS: ________ Original Q's answered? ________ New Q's raied? ________

1	2	3	4	5
terminal		leads to next science activity		generates too many questions

T QUESTIONS

Are Q's primarily:
Factual, definitional?______
Explanatory, predictive?_____
Procedural?_________________

	1	2	3	4	5
	T questions rarely	Few	Several Q's	Often	Too often

Are Q's to:
Further lesson?____________
For evaluation?____________
Attention, discipline?_______

	1	2	3	4	5
	T unskilled questioner		Adequate		Very skilled questioner

T ANSWERS

	1	2	3	4	5
T attitude in answering:	Discourages P		Neutral		Encourages P
T handles P's questions:	T pays no attention	Dogmatic	Re-asks verbatim		Gets P to answer (creatively)
T tolerance/criticalness:	Intolerant Overly critical	Tolerant but critical	Very tolerant, appropriately critical		Overly tolerant, Uncritical

OVERALL

	1	2	3	4	5
T Poise:	ill at ease	Uncertain	at ease	confident	highly confident
T attitude:	negative		bland		enthusiastic
Quality of session:	poor		good		excellent
P involvement:	restless	bored inattentive	passive	involved	engrossed